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A NEW LOCALITY FOR THE ZIGZAG SALAMANDER IN MISSISSIPPI.—*Plethodon dorsalis* Cope was first reported from Missisippi by Brode (1957, Copeia, 4: 308). He found the species common in Tishomingo State Park, Tishomingo Co., thus extending the known range in the Tennessee River drainage, but none was collected across the divide on the Tombigbee side, although a search was conducted there. Recent collecting in the area by herpetology classes from Mississippi State University has confirmed Brode's findings. However, in March and April 1958, we obtained four *P. dorsalis* (deposited in Miss. State Univ. Collection) from about 7 mi. NE Louisville, Winston Co., Miss. This extends the known range about 113 airline miles SW of Tishomingo Park. The collection site is drained by the Noxubee River, a tributary of the Tombigbee, and is situated in the Sand-Clay Hills soil region. It is separated from the Tishomingo locality (North East Highlands region) by the Flatwoods and North East Prairie regions (Soil map of Mississippi, State Dept. Ag., 1942). The latter two regions do not appear to provide suitable habitat for *dorsalis* and it has not been found in this intervening area, despite considerable collecting. In view of these facts, we are inclined to believe that the Winston Co. salamanders may represent a disjunct population, apparently isolated from the main population by a distance exceeding 100 miles.

The specimens were collected in a tract of second growth hardwood, under decaying logs. Two were found in the vicinity of a small stream and two more in a pasture a few feet from the forest edge. The major tree species present are sweetgum, black willow, red and white oak, yellow poplar, American elm, shagbark and mockernut hickory, beech and red maple. Unlike Tishomingo Co., no rocks or outcrops are present, although the topography is hilly. A comparison of our specimens with those from Tishomingo Co. has not revealed major differences, although some minor color variation is apparent.—*Denzel E. Ferguson and Jack R. Rhodes, Department of Zoology, Mississippi State University, State College, Mississippi.*

BURROWING IN THE SALAMANDERS *PSEUDOBRANCHUS STRIATUS* AND *SIREN LACERTINA*.—In 1935, Harper (Amer. Mid. Nat. 16(3) 275-310) reported the uncovering of *Pseudobranchus striatus* from a damp spot in a dried-up swamp. An account of the imprisonment of *Siren lacertina* in a dried-up pond was given by Carr (1940, Univ. Fla. Biol. Sci. Ser. 3). I observed the imprisonment of both *Pseudobranchus* and *Siren* in a small water-hyacinth pond on Payne's Prairie, Alachua Co., Fla. in Feb., 1957. In Sept., 1956, the pond was approximately 30 feet across and 4 feet deep. The water level gradually receded during the dry fall and winter and the pond was completely dry by Feb., 1957. At intervals from Sept. to Feb. *Pseudobranchus,* but no *Siren,* were taken from the pond.

By Feb. 23, the water table had dropped to 20 inches below the pond bottom, which was covered with a mat of dead hyacinths. A segment of the mat was rolled back and a ditch four feet long, one foot wide and a foot and a half deep was dug. Two *Siren* and three *Pseudobranchus* were found trapped in the firm mud. Each was in a separate tunnel the diameter of the animal's body and from 4 to 12 inches below the surface. One *Siren* was in a vertical tunnel which extended to the surface. Its head pointed up and its tail had made an imprint in the hardened, moist mud. The other *Siren* was in a horizontal tube slightly longer than its body and four inches below the surface. No connection to the surface was apparent. Upon prodding, the *Siren* moved out of its tube and dropped to the bottom of the ditch where it was unable to burrow into the mud. The *Pseudobranchus* were in S-shaped tubes slightly longer than their bodies. Only one tube obviously extended to the surface.

On Mar. 15, 1957, five *Pseudobranchus* were put in a gallon, wide-mouth jar containing four inches of mud, a half inch mat of hyacinch roots, and three inches of water. Three of the *Pseudobranchus* were from 80 to 90 mm. long and two were about 40 mm. The jar was kept at room temperature until the visible water had evaporated and the mud had become firm. On May 15, the jar was broken and the block of mud was dried further in the open air of my office until June 6, when it was sliced to expose the *Pseudobranchus*. The three largest were recovered. None was slimy to the touch, as is characteristic, and all had greatly reduced gills. One of the smaller was cut in two in the process of recovering the larger ones. The other small one was not found, but a small empty tube indicated it had died and decayed in its burrow. The three survivors were put in water and in one week their gills returned to normal size.

The tunnels of the larger animals opened to the lower surface of the mat of hyacinth roots. Their inner surfaces were not moist to the touch. They were S-shaped and extended to the bottom of the jar; one had a side branch that also reached the bottom.

Apparently *Pseudobranchus* and *Siren,* when exposed to the conditions of a drying pond, will burrow into the bottom. An opening may be left to the surface if the condition of the mud is suitable. The dried mud may imprison the animals, but they are able to survive two months of dry conditions.—*John R. Freeman, Dept. of Biol., Univ. of Fla., Gainesville.*

Marking and Banding Frogs and Turtles

By HAROLD M. KAPLAN

The recognition of the identity of individual frogs and turtles held over long periods for experimentation is a problem that has been attacked with variable success.

Aquatic animals present unique problems in identification, chiefly through fading and toxicity of dyes, rusting of external bands, and handicaps to movement and bodily processes. The problem in aquatic turtles has not been too difficult. Cagle (1939, Copeia, 170-173) filed notches in the carapace and plastron with triangular and square-edged files. He later (1944, Misc. Pubs., Univ. of Michigan, No. 61, pp. 1-34) employed an electric grinder mounted in a drill stand. In young specimens the toes were clipped because of possible destruction of plate markings with age.

Other useful methods for turtles include adhesive tape strips, scarring the shell, and the use of finger nail polish. These are adequate for temporary identification.

Bogert (1937, Copeia, 3: 191-192) marked desert tortoises with aluminum tags, although he did not describe their type and bodily location. We have modified this technic (which is known in the literature) with commercially available aluminum bands (National Band and Tag Co., Newport, Ky.), primarily used as leg bands in birds. These bands are illustrated in Fig. 1. They have permanently embossed numbers running from one to 10,000. We bore two small holes with an electric drill in the marginal plates of the carapace, and insert the flange of the band through one hole, bringing it up through the other and securing it through the slot fastener. The band is permanent, non-toxic for all practical purposes, and visibly numbered.

The problem in frogs is more difficult. We have evolved two methods of identification. In the first, a tiny aluminum cylindrical band (butt-end bird band, #1242, size 2½, National Band and Tag Co.) is placed around one toe. The two ends of the expandable band are pressed together with a pair of pliers so that they join firmly upon being made to pierce through the web between the toes. The cylinder is closed just tightly enough around the toe so that it does not cut off circulation. These bands are available in serial numbers from one to 100. They do not appear to restrict movement or to significantly impair circulatory or other functions, and they stay fixed indefinitely. The tiny numbers are somewhat difficult to read upon a cursory observation but they are readily visible with a hand lens.

We have employed a second method in frogs that is even better, although a little more time consuming than banding the toes. The skin of the upper whitish abdomen is scarified with a #27 hypodermic needle, the scarification being imprinted as one or more given numerals. The pressure is just light enough so that the needle does not penetrate through the entire depth of the skin. India ink is then put into the numeralized skin grooves.

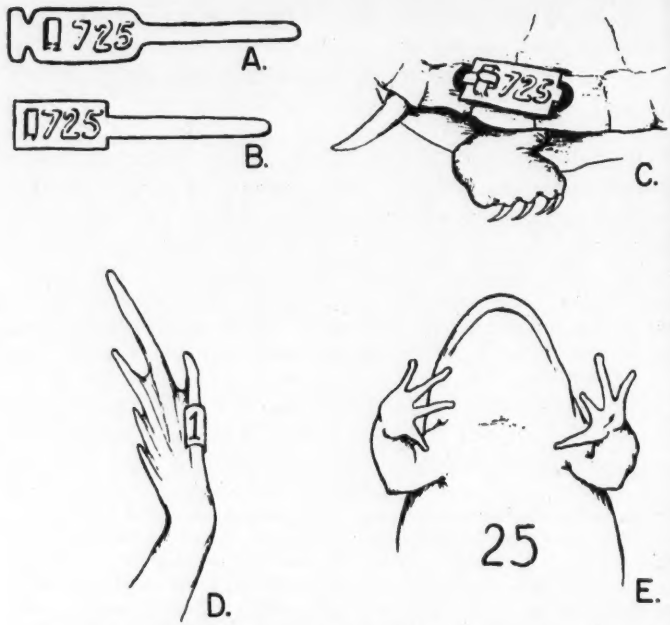

Fig. 1. A. The numeralized band for turtles as purchased. B. The band custom cut to obtain a long flange. C. The band inserted through two holes in the carapace and secured. D. The butt-end bird band in place on a toe of the frog. E. India ink scarified to form numerals on the belly of a frog.

The frogs do not become infected, the erythema disappears rapidly, and the numbers stand out vividly. We have kept many frogs over three months immersed in tanks of flowing cold water, without any signs of irritation from the treatment and with no obliteration of the marks. We have also tried duplicator inks and trypan blue, but these fade in a short time. Trypan blue is durable for a few weeks. Fig. 1 shows the method used in frogs.

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Notes on Larval Toads in the Eastern United States with Special Reference to Natural Hybridization

By KENNETH L. GOSNER and IRVING H. BLACK

Despite the ease with which tadpoles of most species may be obtained in the field, or reared in the laboratory, such material has been used to a very limited extent to investigate natural hybridization. The present study was undertaken to evaluate a collection made in New Jersey of approximately fourteen hundred toad larvae which were presumed to include tadpoles of *Bufo terrestris americanus* and *Bufo woodhousei fowleri* as well as hybrid larvae from sympatric populations. As a preliminary a brief review was made of criteria for separating larvae of additional species east of the Mississippi River. Six forms require mention: *Bufo t. terrestris, B. t. americanus, B. t. copei, B. woodhousei fowleri, B. valliceps,* and *B. quercicus.* The study was based largely on Newark Museum material and we are indebted to Mr. Neil D. Richmond for permission to examine Pennsylvania and Quebec specimens in the Carnegie Museum. Thanks are due also to Dr. E. Peter Volpe, Tulane University, for the loan of Louisiana material, for critical comments on the manuscript and for other assistance.

Materials.—The following larvae were examined: 270 *B. t. terrestris* in six series from Nansemond Co., Va.; Marion Co., S. C.; and Charlton Co., Ga.; 12 *copei* from Great Whale River, Quebec, Canada; 725 *americanus* in 13 series from Morris, Passaic, and Sussex counties, N.J.; Allegheny, Butler, and Westmoreland counties, Pa.; and Cape Breton Island, Nova Scotia, Canada; 385 *fowleri* in 26 series from Morris Co. and nine Coastal Plain counties in N.J.; Moore Co., N.C.; and St. Tammany and Orleans parishes, La.; 787 *americanus* x *fowleri* "hybrids" in eleven series from Morris, Sussex, and Warren counties, N.J.; and Pike and Bradford counties, Pa.

Limbaugh and Volpe (1957) defined and illustrated forty-six stages in the embryonic and larval development of *valliceps* and their tables have been used to stage larvae in the present study. In order to facilitate comparisons with stages in the larval development of *Rana pipiens,* figured by Taylor and Kollros (1946) and previously used by us to stage larvae of other anuran families, we have designated both systems in Fig. 2.

Criteria for Species Identification.—Wright and Wright (1949) presented a tentative key to tadpoles of the U.S. As indicated by Nichols (1937) their summary did not show changes during development, nor was the range of individual variation adequately represented. A brief review of key criteria is, therefore, in order.

Larvae of *valliceps* differ mainly from members of the *terrestris-woodhousei* group in labial tooth row proportions and melanoid pigmentation of the tail musculature. (Unless otherwise indicated all subsequent references to tail pigmentation refer to the musculature) The three lower labial tooth rows are of nearly equal chord length in *valliceps* whereas in the *terrestris-woodhousei* complex the third lower row is usually shorter. The tail of *valliceps* is dark with a series of light spots

along the dorsal margin and a few scattered laterally. Data presented by Limbaugh and Volpe (*op. cit.*) indicate that the traits cited above remain fairly constant during the larval period of *valliceps* except: "complete mouth parts are present only between stages 29 and 40," and prior to about stage 30 there is considerably less pigment in the ventral half of the tail, giving in the earliest larval stages a bicolored pattern with a series of light spots along the dorsal margin. Tadpoles of the *terrestris-woodhousei* complex, in contrast to *valliceps,* have the tail more or less bicolored throughout the larval period; we have found little change in these patterns when comparing larvae at different growth stages. The proportion of dark to light differs in the four forms as described below and shown in Fig. 1. Tadpoles of *fowleri* from N.J., N.C., and St. Tammany Parish, La., have a ventral unpigmented stripe averaging 40 per cent of the width of the musculature at its base. A series of

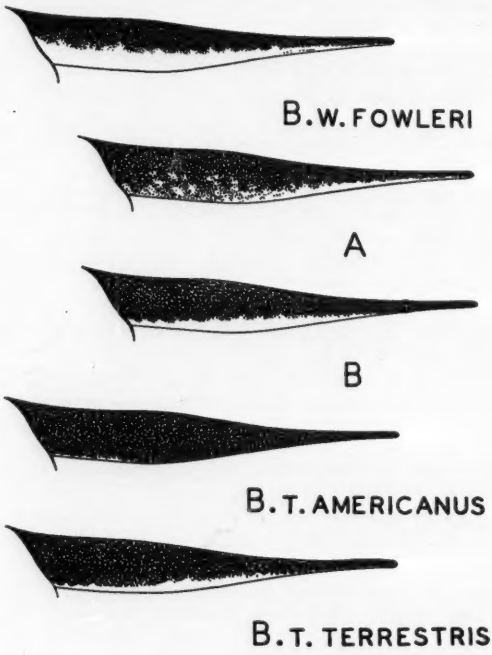

Fig. 1. Melanoid tail musculature patterns of eastern toad larvae of the *terrestris-woodhousei* complex. *Bufo woodhousei* fowleri, NM Z53.403 from Gloucester Co., N. J.; A and B, *americanus* x *fowleri* hybrid larvae, NM Z53.191-2, Sussex Co., N. J.; *B. terrestris americanus,* NM Z55.319, Morris Co., N. J.; *B. t. terrestris,* NM Z54.452, Charlton Co., Ga.

fowleri from New Orleans has the light stripe relatively narrow, averaging only 22 per cent (range 17-25 per cent in ten specimens). In *terrestris* the light stripe is even narrower, averaging 7.2 per cent in Charlton Co., Ga. Other *terrestris* samples were similarly marked. The pattern in *americanus* and *copei* involves a further narrowing of the unpigmented ventral fraction and in some samples the tail is uniformly dark. Wright (1914) and Walker (1946) have described the musculature as dark in New York and Ohio *americanus*. Because of individual variation, the series *americanus-terrestris-fowleri* presents a picture of continuous variation in the relative extent of dark and light areas in the tail. The clear-cut separation of *terrestris* larvae from *americanus* or *fowleri* on the basis of tail patterns alone is problematic; in cases of suspected interbreeding it is possible that rigorous statistical examinations could yield useful data. Larvae of *quercicus* also are reported to have a distinctive tail pattern; Wright and Wright (*op. cit.*) mentioned six or seven black saddles on the dorsum of the musculature of this form. The incomplete description of *quercicus* larvae has not been amplified by other observers.

Differences in intensity of body pigmentation have been reported between *fowleri* and *americanus* in Okla. by Bragg (1946); this criterion appears to be subject to geographic variation, however, and the indicated difference does not serve to separate the two forms in N.J. Markings in tail fins of tadpoles are also subject to ontogenetic and possibly geographic variation.

Preliminary studies of individual and ontogenetic variation indicate that a number of other differential traits of the *terrestris-woodhousei* group may not be of practical value and the selection of additional criteria for identification is, therefore, difficult. Size, for example, was rejected as a "key" trait when it was found that the size-staging curves of *americanus, terrestris* and *valliceps* are nearly equivalent to that of *fowleri* as figured by Gosner and Black (1954). Larvae of *terrestris* and *valliceps* may average slightly smaller and *americanus* slightly larger than the indicated *fowleri* curve, but the range of variation broadly overlaps that found in different samples of *fowleri*. It is obvious that an analysis of larvae suspected to be of hybrid origin should be based on a knowledge of variation in the parental forms present in the area from which the hybrids were obtained.

For the purpose of evaluating northeastern larvae in terms of hybridization between *americanus* and *fowleri* the ratio internasal/head-body length was found useful. The internasal distance was measured between the inner margins of the nostrils with an eyepiece micrometer disc and binocular microscope. Differences in this ratio and in tail pigmentation were the chief morphological criteria used. The scatter diagram of Fig. 2 and the fitted curves of Fig. 3 indicate differences in the internasal ratio between standard series of *americanus* and *fowleri*.

Standard series of *fowleri* and *americanus* larvae were reared from eggs laid in the lab. or taken from choruses of known composition. Larvae of *fowleri* from N.J. Coastal Plain localities were presumed to be "purer" than those from areas where *fowleri* and *americanus* are sympatric. The selection of standard series of *americanus* from local sources is more difficult because of the possibility that New Jersey *americanus* is

more or less contaminated from interbreeding with *fowleri*. In this regard the average for the internasal ratio of the Cape Breton sample of *americanus* falls considerably below that of the N.J. material. It should also be noted that there is a marked geographic variation in the internasal ratio between *fowleri* larvae from the northeastern part of its range (N.J. and N.C.) and those from La. (Fig. 2). This variation may parallel the morphological and physiological differences found by Blair (1943) and Volpe (1955) in comparing adult *fowleri* from the lower Missisippi valley with other populations of this toad. As indicated in Fig. 2, the internasal ratio changes during growth and there is considerable individual variation. Similar allometric changes effect other morphological traits likely to be used for taxonomic studies.

Hybridization.—Larvae of experimental hybrids between *fowleri* and *valliceps* were described by Volpe (1956) who found that crosses involving female *valliceps* and male *fowleri* do not produce viable offspring whereas up to seventy-four per cent of the hybrids developed normally in reciprocal crosses. Although hybrid inviability may serve as a partial

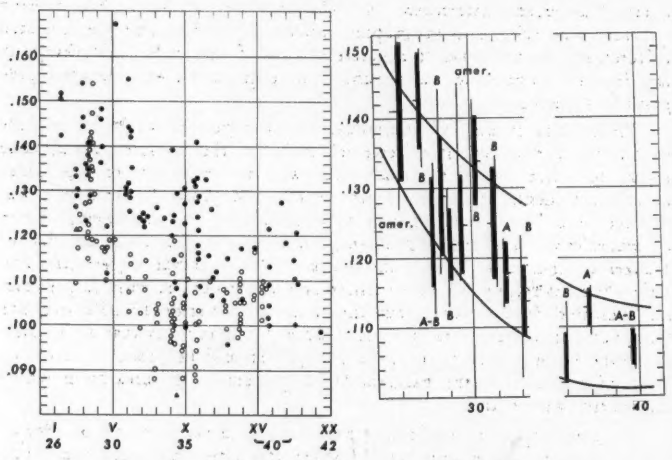

Fig. 2 (left). Variation in internasal/head-body ratio vs. larval stages in N. J. *fowleri*, solid circle and *americanus*, open circle. Solid circles are mean internasal ratios of *fowleri* from St. Tammany Parish, La. Roman numeral stages from Taylor and Kollros (1946), arabic stages from Limbaugh and Volpe (1957). Stage 41 of the latter includes Taylor and Kollros stages XVIII and XIX.

Fig. 2 (right). Variation in internasal/head-body ratios and tail musculature patterns in *americanus* x *fowleri* hybrid larvae. Upper curve, *fowleri*, lower curve *americanus*. Thin portion of vertical lines show observed range, thick portion, standard deviation, crossbar equals mean. Musculature pattern designations refer to Fig. 1. Larval stages on abscissa, ratios on ordinate.

isolation mechanism in the case of *fowleri* x *valliceps,* reproductive isolation generally appears to be less effective in separating sympatric populations of toads in the *terrestris-woodhousei* complex. In the case of *americanus* and *fowleri,* whose ranges overlap in a considerable area in the eastern U.S., natural hybridization is known to occur and experimental F_1 hybrids between these two forms have been found to be fertile. Natural hybridization has generally been attributed to "secondary intergradation"—to the breakdown of a habitat isolation mechanism which existed prior to human interference. A brief review of the situation in N. J. forms a necessary preliminary to our evaluation of the larval material.

The distribution of *americanus* in N. J. terminates near a line drawn roughly from Stockton, Hunterdon Co. to Pompton Lakes, Passaic Co. and then curving eastward to include northern Bergen Co.; *fowleri* is found throughout the state but is more abundant in the Coastal Plain. The total area of overlap in northern N. J. is about 2000 square miles. Within this area the population density of the two forms may be nearly equal; although occasional choruses in the northern area are equivalent in size to many found in the Coastal Plain, large northern choruses are not so abundant. This may be due to a restriction of available habitats in the better-drained uplands in comparison to the Coastal Plain where abundant breeding situations normally occur in flooded fields, sand pits and shores of pine barrens' lakes and ponds. The Coastal Plain supports a large assemblage of *fowleri* individuals; because of the greater density of the population in this area it seems reasonable to expect that effective gene flow would be chiefly from the Coastal Plain into northern N. J. rather than in the reverse direction. This trend should have two important consequences as far as *americanus* x *fowleri* hybridization is concerned; first in helping to counteract the adulteration of northern *fowleri* genotypes; and second in supporting increased contamination of the *americanus* stock. Because of the semi-peninsular nature of N. J., the Delaware River serving to some degree as a deterrent to free interbreeding of N. J. and Pa. *americanus,* the flow of *americanus* genes into northern N. J. may be more limited.

The chief factor tending to separate breeding choruses of *americanus* and *fowleri* in N. J. probably is seasonal isolation. Vocal activity was used to gauge approximately the extent of the breeding season and its period of greatest activity. We have heard *americanus*-like calls in Morris, Passaic and Sussex counties as early as April 8-10 and choruses composed entirely of long, high-pitched trills usually continue the rest of the month. The latest record we have for a "pure" chorus is May 14 in a cool plateau area of Sussex Co. Usually *fowleri* does not begin calling in northern N. J. before May 5-16, but its short, lower-pitched "screams" have been heard in Sussex Co. as early as April 21.

During May many choruses in northern N. J. are dominated by vocalizations that we may term "hybrid" calls. These do not conform to a single intermediate type, but include a variety of abberrant vocalizations outside the normal range of variation of *fowleri* and *americanus* calls. Choruses of this type have been observed as early as the third week in April in Sussex Co. and as late as May 23 in Passaic Co. A few such calls were heard with a *fowleri* chorus on June 6 in Morris Co. Since

hybrid choruses frequently develop in situations previously used by *americanus,* and subsequently occupied by *fowleri,* we conclude that habitat selection is not an important isolation mechanism for these forms in northern N. J. The effectiveness of seasonal isolation as a deterrent to interbreeding of *americanus* and *fowleri* populations varies locally and from year to year. For example, at a flooded sand pit near Swartswood Lake, Sussex Co. where choruses have been observed over a period of several years the usual seasonal calling sequence (*americanus*-hybrids-*fowleri*) was disrupted in 1954, presumably by low nocturnal temperatures early in the season. Thus no toads had spawned by April 14 but when the locality was visited a week later, following a marked warm spell, a mixed breeding chorus was in progress with *fowleri*-like vocalizations already in the majority. In this instance unmixed breeding assemblages of *americanus* could have been maintained for only a few nights, at most, before hybrid and *fowleri*-like toads became sexually active.

The calling season of *americanus* is apparently shorter in N. J. than in some other parts of its range. In central Ohio, for example, *americanus* calls from late March to early July according to Walker (*op. cit.*), and at Ithaca, N. Y., Wright (*op. cit.*) reported extreme dates of March 30 and July 15. In both areas breeding activity reaches a peak in April or early May, as it does also in N. J., although eggs were found in Ohio as late as June 10 and July 25 at Ithaca. The abbreviated vocal (and breeding?) season of N. J. *americanus* contrasts with that of *fowleri* which breeds from late April to mid August in central N. J.

To summarize the preceding paragraphs, we find a situation in N. J. in which *fowleri,* because of its greater abundance, wider distribution, and longer breeding season might be termed the "dominant" toad species. A hybridization zone between this form and *americanus* includes most of the northern part of the state where weakly operative isolation mechanisms do not effectively separate the two forms. As a long term trend there is likely to be increasing contamination of the *americanus* breeding population by *fowleri*-like gene combinations. With these propositions in mind we may examine the larval material.

Evaluation of Larvae.—Nine series of larvae from northern N. J. and two from Pa. were regarded as hybrid in origin. Some of the series contain tadpoles at widely different stages of development and to facilitate analysis these were broken up into size classes covering two or three developmental stages. Tail patterns were examined in all specimens available and internasal ratios were calculated from samples taken at random from each series; the total number of internasal measurements made was 166, Fig. 3.

Among toad tadpoles from northern N. J. continuous variation was found in tail patterns, from typical *fowleri* through types A and B of Fig. 1 to typical *americanus.* Similarly, the range of internasal ratios is more or less continuous from one parental extreme to the other. Despite the increased variability of the hybrid material, taken as a whole, individual hybrid samples are frequently no more variable than the standard series; this is true of both the tail patterns and internasal ratios. Coefficients of variability (C.V.=standard deviation x 100/mean) of the internasal ratios in the hybrid series range from 2.3 to 7.7. Equivalent variability was found in the standard series of *fowleri,* both in the inter-

nasal ratio and in other, non-meristic traits. For example, the C.V. of head/body length of fifteen *fowleri* tadpoles at Stage 31 was 6.6.

Although most of the hybrids were intermediate in *both* traits, occasional departures suggest that the traits are inherited independently. This point is illustrated by a series of stage 34-37 tadpoles (CM 29215) from Bradford Co., Pa., taken June 20 where both parental forms occur (*fowleri* calling at the time larvae collected). In this series the average internasal ratio was below the mean of N. J. *americanus* at an equivalent stage; tail patterns, however, were generally of type A, Fig. 1 with a few excellent *americanus* and a few near *fowleri*. A second example from Passaic Co., N. J. suggests also the extent to which "good" *americanus* may be contaminated by *fowleri*-like gene combinations. This series was raised from eggs laid by adults taken from an *americanus* chorus on April 8, 1953. The eggs had *americanus*-like jelly envelopes and the tail patterns were of the type shown in Fig. 1. The internasal ratios, however, average considerably above the *americanus* curve; this series is, in fact, responsible for all of the stage 29 records above .130 in Fig. 2. Collecting dates for the hybrid material range from April 21 to June 23 and stages 2-41 are represented. Relating these data to estimated growth rates we find support for supposing that the intermediate material originated with hybrid breeding choruses.

Collections made serially during a single season reveal the changing composition of the breeding choruses. Three samples from Sussex Co., N. J. illustrate this point. Thus, a series of larvae reared to stage 29 from eggs collected April 21 developed typical *americanus* musculature patterns and the internasal ratios average slightly below the *americanus* curve in Fig. 3. On May 18 several hundred larvae were taken at the same locality. Four size-staging classes made up this series as follows: stages 28; 29; 31-33; 36-39. The internasal ratios of the three more advanced samples average near the *americanus* curve, but their tail patterns vary; stages 36-39 are *americanus*-like whereas the other two samples include more intermediates of type B, Fig. 1. Members of the fourth or youngest size class in the series have patterns between type B and typical *fowleri* whereas the internasal ratios average well above the *fowleri* curve for this stage. Additional larvae were collected June 10 in the same breeding pool; these were at stage 27-28 with typical *fowleri* patterns and internasal ratios averaging well within the range of this form. All of the preceding larvae were collected in the same breeding situation and additional samples taken in adjacent localities follow a similar pattern.

The present analysis of larval collections was aided considerably by supplementary data on the composition and succession of breeding choruses of adult toads. In the absence of such aid the determination of individual samples of larvae, as *americanus*-like, *fowleri*-like, or intermediate is more difficult, but because of this very difficulty such collections can be profitably employed in studies of natural hybridization. They can be used, for example, in plotting the distribution of hybrid populations and they accurately reflect the changing composition of choruses in individual localities. Under conditions where the time available for field study of adult breeding assemblies is limited, toad tadpoles should be of aid in providing information not otherwise obtainable.

LITERATURE CITED

Blair, A. P., 1947. Variation of two characters in *Bufo fowleri* and *Bufo americanus*. American Museum Novitates 1343: 1-5.

Bragg, A. N., 1950. Researches on the Amphibia of Oklahoma. Univ. of Okla. Press, Norman, 9-29.

Gosner, K. L. and Black, I. H., 1954. Larval development in *Bufo woodhousei fowleri* and *Scaphiopus holbrooki holbrooki*. Copeia (4):251-5.

Limbaugh, B. A. and Volpe, E. P., 1957. Early development of the Gulf Coast toad, *Bufo valliceps* Wiegmann. American Museum Novitates 1842: 1-32.

Nicholas, R. J., 1937. Taxonomic studies on the mouth parts of larval Anura. Ill. Biol. Monographs XV (4): 9-73.

Taylor, A. C. and Kollros, J. J., 1946. Stages in the normal development of *Rana pipiens* larvae. Anat. Rec. 94:7-23.

Volpe, E. P., 1955. Intensity of reproductive isolation between sympatric and allopatric populations of *Bufo americanus* and *Bufo fowleri*. Amer. Nat. LXXXIX: 303-318.

Volpe, E. P., 1956. Experimental F_1 hybrids between *Bufo valliceps* and *Bufo fowleri*. Tulane Studies in Zool. 4 (2): 61-75.

Walker, C. F., 1946. The amphibians of Ohio, Part I. Ohio State Mus. Sci. Bull. I (3): 1-110.

Wright, A. H., 1914. North American Anura. Carn. Inst. Wash. Publication No. 197: 1-98.

Wright, A. H. and Wright, A. A., 1949. Handbook of Frogs and Toads. Comstock Publ. Co., Ithaca, N. Y.

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THE SMOOTH GREEN SNAKE IN THE VIRGINIA BLUE RIDGE MOUNTAINS.—*Opheodrys vernalis vernalis* (Harlan) has previously been reported in Virginia only in the area of Clifton Forge (Hoffman, 1945, Herpetologica, 2:203). According to current information it ranges across northeastern U. S. and into the Appalachian Highland from Maryland to western North Carolina and eastern Tennessee (Wright & Wright, Handbook Snakes, 1957: 552).

One specimen (USNM 138740) was collected by Miss Patricia Kruser and me at Forks of Buffalo, Amherst Co., Sept. 2, 1956, el. 1,000 feet. I collected another (USNM 139393) in the Shenandoah National Park at Tanners Ridge Overlook, 3600 feet, near Big Meadows, Page Co., July 16, 1957, 80 mi. N. of the first locality and 120 mi. S. of the only Maryland records from Frederick and Washington counties (McCauley, Reptiles Maryland, 1945:72).

A southeastern extension from the main range of *vernalis* is evident; a narrow finger extends down the Blue Ridge paralleling the Appalachians to the west. This same sort of southward extension occurs in the Wood Turtle, *Clemmys insculpta*.

I am indebted to Mr. C. K. Dale, Dr. Doris M. Cochran, W. L. Burger and Dr. T. Paul Maslin for their aid.—*William L. Witt, 1412 Patrick Henry Drive, Apt. 121, Arlington 5, Virginia.*

Social Behavior in Juveniles of *Bufo cognatus* Say[1]

By ARTHUR N. BRAGG[2] and MAURICE BROOKS[3]

Except for sexual reactions, social behavior has been noted rather rarely in Amphibia in contrast to other vertebrate classes. Territoriality, common in many fishes, birds and mammals, may be weakly developed in *Rana catesbeiana.* Homing has often been attributed to various species of *Bufo.* Suggestions of parental care in some salamanders (e.g., *Amphiuma means* and some Plethodontidae), which often remain with the eggs and possibly protect them, are known; also members of the Pipidae, Alytes, and a few other salientians carry eggs or young. Leadership, apparently without social dominance, is described in the initiation of breeding choruses of several species of Salientia (Goin, Quart. Jour. Fla. Acad. Sci., 11: 59-64; Bellis, Copeia, 1957: 85-89).

We understand that social behavior exists when an animal behaves differently in the presence than in the absence of others of its species. Basically, therefore, social behavior is always a reaction to other members of the species rather than to physical factors of the environment, although these may greatly modify its expression. The social behavior of many vertebrates and some invertebrates, as social insects, seems to have a genetic basis. In other animals we see social behavior, such as mass migration, manifested only under special conditions—social, physical, or some combination thereof. Where hereditary fixture is weak, we expect social behavior to be expressed only when certain environmental stimuli are present. Even when it is strong, stumuli of some sort are characteristically involved (*viz.* Tinbergen, 1951, *The Study of Instinct,* and literature cited on theory of releasers in social behavior; Oliver, 1955, *Nat. Hist. N. Amer. Amphs. Repts.,* on known behavior of North American Amphibia; and Noble, 1954, *Biology Amphibia,* for world-wide summary).

This paper reports observations on the Great Plains Toad, *Bufo cognatus* Say, which we believe represent social phenomena of two types: (1) mass migration and (2) aggregations of many individuals in a limited area where no consistent correlation with environmental factors could be found. The mass movements reported in northern United States were observed by Brooks and those in Oklahoma by Bragg. Our observations were made independently. Each was greatly puzzled by what he had seen, especially by his failure to find environmental correlations. We present the observations, leaving most interpretations to later developments.

The first suggestion of mass migration of *cognatus* was in 1939 in central Oklahoma. Observations during the next few years resulted in a description of the phenomenon by Smith and Bragg (1949, Ecology, 30: 333-349). Local movements in one compass direction were observed, but limited to late spring and early summer. Significantly, *B. woodhousei,* sympatric with *cognatus* in central Oklahoma and often on the roads with it during such directional movements, did not move in one direction.

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Most individuals in such mass movements were young of the year, but there may be more juveniles in the population during migration than at other times.

Smith and Bragg's (1949) observations were made over a period of several years of nearly normal rainfall. The following observations occurred during two widely separated seasons of phenomenally heavy rainfall in the spring or summer in parts of the grasslands. Heavy rain on the prairies usually results in large numbers of juveniles of prairie species of *Bufo* (Gunter, Copeia, 1941: 266; Bragg, 1942, Science, 95: 194-195) and may have some bearing on the sudden development of unusual population pressures.

Observations

Following are Brooks' observations in northern North American grasslands in 1941, when young toads were extremely abundant in several widely separated regions (Gunter, 1941; Bragg, 1942, *op. cit.*).

On August 3, 1941, newspapers throughout northwestern United States carried stories of the appearance of "millions" of toads around Grand Forks, N. D. Toads, in an unprecedented movement, had invaded towns, entered cellars and become a major nuisance. Highways were made slippery by their crushed bodies as automobiles destroyed untold numbers.

On August 10, Mrs. Brooks and I drove to Arvilla, N. D., to observe this phenomenon. No toads were seen along highway U.S. 2 until about ten miles east of Crookston, Minn., where we found the road and berms covered with toad carcasses and a considerable number of toads crossing the highway. We went westward 45 miles, past Grand Forks, N. D. Toads were in very large numbers often through Minnesota and continuously after we crossed the Red River into N. D. We saw hundreds in Grand Forks and they seemed more abundant as we travelled westward. It was rainy, drainage ditches along highways were filled and low-lying prairies flooded. The weather had been very warm for ten days, with temperatures occasionally 100°F.

Near Crookston we made counts of the recognizable dead toads on ten consecutive 30-linear foot sections of highway attempting to choose a fairly representative area. These counts were 57, 64, 52, 48, 52, 71, 68, 63, 59, and 62, mean 59.6. The dead toads along the berms were not counted, nor were carcasses counted that were indistinguishable from *Rana pipiens,* many of which were on and along the highway. Live toads were not counted, since there was constant movement.

Extraordinarily, *every individual* among the thousands seen was moving north. We were unable to find any exceptions. Even when disturbed they would circle to move north again.

Intersections with the main paved east-west road presented amazing spectacles. The toads tended to crowd because passing cars interferred with their movement and highway mortality was at its peak. Just west of Grand Forks we spent some time at an intersection, following the steady northward movement. With field glasses we could see steady hopping for a considerable distance, all individuals moving as though impelled by a driving force. The gravel road seemed alive and in motion itself. The association with certain events of ancient Egyptian history, as detailed in the book of Exodus, was inescapable.

Extensive series were collected in Minn. and N. D. and identified locally, with a very few exceptions, as *Bufo cognatus* Say. Identification was confirmed by Dr. M. Graham Netting and Dr. W. J. Breckenridge, Univ. of Minn.

Toads colected Aug. 10 and later, in Minn. and N. D. were remarkably uniform in size and color. All were sub-adults, the cranial crests lacking or poorly developed. Careful search on this and nine subsequent trips failed to yield any adult *cognatus*. Oblique streaking on the sides was conspicuous. Fifty-six individuals ranged in snout-vent length 30.5-51.7 mm., mean approximately 44 mm.[4]

Near Crookston we collected a few *Bufo hemiophrys* Cope, also sub-adults, which were a scarcely noticeable part of the movement.

"August 10. Grace Bratlee, driving from Moorehead to Breckenridge, Minn., reported thousands of toads like those I collected the same day, *all moving northward*. None was collected. This area is sixty to one hundred miles south of Crookston and Grand Forks.

"August 13. I made a trip to the Crookston-Grand Forks region with George Mueller in an attempt to define the limits of the *cognatus* movement. The day was bright, sunny and reasonably warm. We first noticed toads along U.S. 2 east of Crookston where we found them previously. We crossed the Red River into Grand Forks and saw many more toads in the town than on the previous trip, Aug. 10. We continued to find them in numbers to the Campbell beach line of old Lake Agassiz near Arvilla, Grand Forks Co., N. D. Just beyond the beach line there were no more toads.

"We continued west to Larimore, N. D., then north twenty miles, then east through Poland, N. D., to Warren, Marshall Co., Minn. Not a toad was seen on this trip, although we examined berms and ditches. Turning south at Warren, we found no toads until we reached Euclid, Polk Co., where they again appeared in numbers. This is the farthest north at which toads were found on any of our trips and they were still moving north.

"August 16. Around noon and early afternoon, in bright and warm weather, we found numbers of *cognatus* and one or two *hemiophrys* on the outer (Herman) Lake Agassiz beach line, both near Ulen, Clay Co., and Syre, Norman Co., but none east of Herman Beach.

"August 19. Toads were again found in the Syre region, with weather hot, thunder showers in the afternoon. Between Crookston and Arvilla, N. D., during heavy rains *cognatus* was again abundant, especially around East Grand Forks, Minn. At the Campbell Beach line at Arvilla they again were absent. Farther west in N. D., near Lakota, Nelson Co. and Bartlett, Ramsey Co., we collected a few adult *hemiophrys*, but no *cognatus* there or at Devil's Lake. All *cognatus* were moving north, even in the heat of midday, when the toads were crossing U.S. 2 in numbers.

"August 20. Returning to Itasca, weather warm and clear, one toad seen near Arvilla. This was the farthest west we saw *cognatus*. During the hot mid-afternoon toads were abundant along the highway until we reached the Herman beach line east of Crookston.

"August 21. I found *cognatus* as far north as Brooks, Red Lake Co., Minn."

From observations throughout a territory 125 miles N-S and 55 miles

E-W Great Plains toads were extraordinarily abundant. They were also found much farther south than this in Minn. and S. D., but they probably did not extend much north of Polk, Marshall, and Red Lake counties, Minn., and Grand Forks Co., N. D., during August. No Sept. observations were made in these regions, so the toads may have moved down the Red River Valley after our visits. Miss Grace Bratlee informs me that toads, presumably *hemiophrys,* were abundant along highway U.S. 2 in the Devil's Lake region of N. D. Aug. 29, and in great numbers as far west as Minot (130 miles beyond Devil's Lake) on Aug. 30.

Dr. George H. Happ, of Principia College, Elsah, Ill., writes December 16, 1941: ". . . From July 21 through August 8 I saw large numbers of . . . *cognatus* . . . on the roads from about thirty miles west of Wahpeton to the Red River valley . . . on the morning of August 2, as I watched them crossing the road, it seemed they were heading almost directly north . . . The smaller size would indicate they were of a comparatively recent hatch, possibly of the 1940 season . . ."

In correspondence with M. Graham Netting, Dr. W. H. Over, Univ. of S. D., writes December 1, 1941: "Yes, we have in many seasons, usually during August, noticed this movement of young toads (*Bufo cognatus*), that had hatched the previous spring, but never the adults. Nor have we considered it a 'migration,' rather only a local movement, either forced from a dry area to one of more moisture, or seeking a more favorable location for hibernation. While crossing highways the mortality is great. This movement usually takes place after a heavy rainfall . . ."

During my visits to the Crookston-Grand Forks region I inquired of every local person I met about occurrence of such oubreaks as that of 1941. Of dozens questioned, none had seen anything like it previously. One farmer said to have lived near East Grand Forks for nearly seventy years had never before seen such an outbreak.

Wahpeton, N. D., where Dr. Happ's observations were made, is almost due west of Breckenridge, Minn., the southernmost point from which we have August records. Miss Bratlee sent me two specimens collected in Sept., 1941, at Clarkfield, Yellow Medicine Co., Minn., south of Breckenridge. The animals were abundant, invading buildings. Both specimens are sub-adults about the same as August examples from farther north, so this may well represent a part of the same toad movement.

Local outbreaks of *cognatus* are known in the northwestern states as evidenced by Breckenridge (Copeia, 1938: 47). He writes of local abundance in southwestern Minn. Toads measured in July and August averaged 41 mm. in length, whereas September individuals averaged 53. He concluded that these may have been two years old. [In Oklahoma most toads of this size would have been young of the year, cf. Bragg and Weese, 1950, Res. Amph. Okla: 47-58. ANB.]

The points which separate the 1941 movement from any previously recorded outbreaks are, first, the extent of the area affected, and second, the directional nature of the movement, not noted during previous outbreaks. This appeared to be true migration, under unknown compulsion. The lack of any known goal and our failure to find a terminus or inception raise puzzling questions, but not more than in the cases of eruptive migrations among gray squirrels, red crossbills of the Pacific coast, and other animals.

Age of toads is a matter of conjecture. In Oklahoma (Bragg, 1940, Amer. Nat., 74: 322-349, 424-438) *cognatus* reach the average size of the migrants in about four months under favorable conditions. The shorter seasons of the Northwest are not so favorable for rapid development; Breckenridge believed his specimens to be two years old. *B. cognatus* breeds in the northern part of its range from May to July (Wright and Wright, 1933, Handbook Frogs Toads). Monthly deviations in inches of rainfall above or below normal from May to September are, in *Grand Forks, N. D., 1939:* June —+1.2, July —1.4, Aug. —0.7, Sept. +0.3; 1940: May, no data but rainfall below normal, June —2.5, July +3.6, Aug. —0.6, Sept. no data; *1941:* May, no data, June +4.3, July —2.1, Aug. +1.3; *Moorhead, Minn. 1940:* May —1.5, June —2.3, July +2.0, Aug. +0.4, Sept. —2.0; *1941:* May —1.5, June +1.4, July —2.0, Aug. 0.0.

The toads might have found conditions favorable for breeding at Grand Forks in June, 1939, but would scarcely have bred later that year in a dry period. Bragg concludes that in Oklahoma *cognatus* breeds only after rain; "presence of sufficient water is not enough in itself to stimulate the toads to breed."

The late spring and early summer of 1940 seem to have been unfavorable for breeding at both Grand Forks and Moorhead, but in July unusually favorable breeding conditions occurred. The migratory toads were thus probably from the hatch following the wet July of 1940. Although June, 1941, was highly favorable for breeding, it seems unlikely that resultant specimens would have reached the dimensions of the migratory toads by early August. Breeding earlier than June in these northern latitudes is unlikely even under favorable conditions of moisture, if the temperature is below 54°F. (Bragg).

In Oklahoma specimens are largely nocturnal, although they often appear during daylight in moist weather, especially in the breeding season (Bragg, 1940, *op. cit.*). The free diurnal movement observed in Minn. and N. D. on warm bright days even when the air was 90°F. or above is additional evidence of mass migratory impulse. [However, juveniles in Oklahoma are much more often diurnal than adults. ANB]

Predators did not seem to be unusually abundant. Several species of hawks, notably Marsh Hawks, and garter snakes, *Thamnophis sirtalis parietalis* and *T. radix,* were observed, but they were not evidently preying heavily on the toads.

Several theories that might account for this movement may be considered.

1. Population pressures on an unusual scale due to favorable breeding conditions. Such as dispersal would not, however, be expected to show directional tendencies.

2. Movement toward food. Scarcely tenable because grasshoppers, crickets, and other insects were plentiful on either side of the movement, yet there was no tendency to spread east or west.

3. Search for soft, moist ground favorable to hibernation. Yet in this season of abundant rain there were moist prairies throughout the area.

4. Breeding migration. The toads were sub-adults, however; there was no evidence of breeding. Under a breeding urge we might have

expected dispersal, not a mass directional movement. [Sub-adults of *cognatus* of this size do not breed, at least in Oklahoma. (Bragg and Weese, 1950, *op. cit.*) ANB]

5. Relation to stream flow. There was no evidence that the toads were following watercourses. Toads I observed moved parallel with N-S township and section line roads and were cutting across streams. At two different places I watched them make use of highway bridges. There was no evidence of aggregation at the largest rivers.

6. Finally, it has been proposed that the movement may have resulted from population pressure near the southern boundary of the area affected. This poses the question as to how far the animals might be able to travel. It will be remembered that the movement extended at least on hundred and twenty-five miles N-S, lasted 35-40 days, and that toads were in numbers equally as large toward the north as toward the south. Having walked short distances with the moving animals to gain some idea of their speed, I estimate that in 24 hours they might have moved two or three miles. Hopping was steady at all times, but only had it been maintained for the entire period would it have been possible for an animal to move from the region of Wahpeton or Breckenridge to Grand Forks or Crookston. There is no evidence that such a thing did occur.

July, 1940, was a favorable month for breeding throughout the whole Red River valley. If our toads were of this hatch there is no reason to suspect a population pressure unequally heavy toward the south.

Since none of these theories applies, apparently this case constitutes a genuine eruptive migration. Local seasonal movements of *cognatus,* as well as of such other amphibians as *Rana pipiens* and *Ambystoma tigrinum,* have been noted, but in no case has the scope been so great, nor has there been evidence previously of so strong a directional tendency. Eruptive migrations have been noted among other animals but never with satisfactory explanation of the cause.

The following is Bragg's account of observations near Norman, central Oklahoma, in 1957.

More rain fell during April, May, and early June in this region than during all the previous year, following three drouth years of little or no successful breeding in *cognatus.* Usually heavy rains result in enormous numbers of breeding adults (Bragg, 1940, 1942, *op. cit.;* Bragg and Smith, 1943, Ecol., 24: 285-307), but not in 1957. Congresses were small, because of a gradual decrease in numbers for four years of drouth. Reproduction followed the pattern of rainy years and enormous numbers of young were produced. From an abnormal low, the population jumped suddenly to an abnormal high. Roads were alive with recently emerged young toads in May, because each female produces approximately 20,000 eggs (Bragg, 1940, *op. cit.*). In early July large numbers of juvenile *cognatus* as well as *woodhousei* were being crushed on the roads and many were found in adjacent fields. Not a single adult of *cognatus* was found during the summer.

From July 12 to August 19 at night I was collecting, marking, and releasing juveniles of both species. I observed that in one field whenever a juvenile *cognatus* was seen, others were nearby. On August 1 in a 20′ x 20′ area over which I had wandered regularly, there were 30 to 40

toads, whereas but few were found elsewhere.

On August 3 I visited this region by day to determine the reason for the concentration. The field has been used agriculturally but now had grass and weeds. I could find no difference in moisture, ground cover, types of plants or their distribution, or kinds and numbers of insects present compared to adjacent regions. That evening, 120 *cognatus* were taken, six or eight at a time, in a different region of concentration whereas only one or two could be found elsewhere. Professor Otis M. King who collected with me agreed that at least 200 individuals were present in an area 100 ft. square. There was no concentration where aggregation had been noted August 1. This seems to show that they were not reacting primarily to environment factors.

A light shower fell during the night. The next evening we found no concentrations of toads. The second evening, toads were again concentrated in the second area. Two collectors secured over 40 toads here during the time that another failed to find a single one in other parts of the field which looked to be essentially the same.

A concentration was always present in this area each evening until August 13 although those collected had been marked and released 0.3 mile away and very few had returned. On the 13th, there were two regions of concentration in this field.

It was apparent that juvenile *cognatus* were forming concentrations in local areas, but that rain tended to disperse them. The aggregations were not always in the same places. On August 16 a shower in the afternoon prevented concentrations and none was seen thereafter.

We also collected juvenile *Bufo w. woodhousei* but in smaller numbers—554 as compared with 1500 *cognatus*. We found no evidence of concentrations of *woodhousei* except in obvious relation to moist areas. Several times we found concentrations of both species in moist areas, but such concentrations are not of the same type as those described for *cognatus*. It seems significant that one of two species should consistently be found in aggregations, whereas the other never behaved in this way though subjected to the same environmental influences. This means basic differences in the two species of toads. An interpretation enhanced by earlier observations of Smith and Bragg (1949, *op. cit.*) because it was these same two species that differed in their movements in this locality.

Summary and Conclusions

Two of us working independently in widely separated regions and in different years of heavy rainfall have found juveniles of *cognatus*, when present in large numbers, behaving in an unexpected manner. One of us witnessed an eruptive mass migration in the northwestern prairies, with a strong northward trend. The other found a consistent tendency to aggregate in limited areas in central Okla. whereas another species did not. In neither case was any correlation with environment observed.

These observations, with those of Smith and Bragg (1949, *op. cit.*) on local migration of the same species, give evidence of social tendencies. Dense populations of juveniles appear to react to each other's presence by sometimes migrating extensively or locally with a strong directional trend. At other times they aggregate without migration.

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The Ordinal Name For Tortoises, Terrapins and Turtles

By TIMOTHY J. HUNT

A notable instability exists in the use of the ordinal name for that group which comprises the tortoises, terrapins and turtles. Today three names are in use: Chelonia, Testudinata and Testudines. A short consideration is given to the problem by Stejneger (1907, Bull. U.S. Nat. Mus., 58) who first investigated the problem and adopted the name Testudinata for the reasons mentioned below. More recently M. A. Smith (1931, Fauna Brit. India, Rept. Amph., 1) reconsidered the position and adopted the name Testudines, whereas the name Chelonia which was used by many of the early workers, including Boulenger (1889, Cat. Chel. Rhynch. Croc. Brit. Mus.) has continued to be used by authors of general zoological and nonspecialized works.

History. The oldest name available is Testudines, first used by Linnaeus in the 10th Edition of Systema Naturae (1758, p. 194). "Testudines, muniuntur testa," implying a tent-shaped shell; it is the first of his groups which corresponds to the reptilian orders and higher classes as we know them today. Batsch (1788, Versuch einer Anleitung, zur Kenntniss and Geschichte der Thiere . . .) used Testudines and noted that Linnaeus was the original author of Testudines. Stejneger (*op. cit.*) and Smith (*op. cit.*) who investigated the problem failed to realize that Linnaeus and not Batsch was the first to use this name.

Forty-four years later J. Macartney in the translated work of Cuvier's "Lectures on Comparative Anatomy" used Chelonia as the ordinal name (1802). In the original work of Cuvier (1800) the vernacular French "Les cheloniens" was used. Macartney, or William Ross who translated the work, elevated it to Chelonia. A few years after this latter work, five derivations of the name Chelonia were published and an additional five which are quite meaningless and have not been used since their first publication were also introduced (List of synonyms). In 1811, fifty-three years after the introduction of the name Testudines, Oppel introduced the name Testudinata as the ordinal name.

LIST OF SYNONYMS

1758 Testudines Linnaeus, C., Systema Naturae, 10th ed., Holmae

1802 Chelonia Macartney, J., Lectures on Comparative Anatomy, Translated from the French of G. Cuvier by William Ross, under the inspection of James Macartney, London, Vol. I., tab. iii.

1804 Chelonii Latreille, P.A., Nouveau Dictionnaire d'Histoire Naturelle, Paris, Tom. XXIV, p. 61.

1807 Cataphractae Link, H. F., Beschreibung der Naturalien—Sammlung der Universitat zu Rostock, Rostock, 1806-08, Abth. II, p. 51.

1811 Testudinata Oppel, M., Die Ordnungen, Familien und Gattungen der Reptilien, Munchen, p. 3.

1814 Perostia Rafinesque, C.S., Specchio della Scienza o Giornale Enciclopedico di Sicilia, Palermo, Vol. II. Num. ix. p. 66.

1822 Chelonea Fleming, J., The Philosophy of Zoology, Edinburgh Vol. II., p. 268.

1825 Fornicata Haworth, A. H., A Binary Arrangement of the Class Amphibia, Philos. Mag., pp. 372-373.
1828 Chelynae Wagler, J. G., Conspectus Systematis Amphibiorum, Isis, XXI, Leipzig, p. 861.
1828 Sterrichrotes Ritgen, F. A., Versuch einer Natürichen eintheilung der Amphibien, Nova Acta Acad. Leop. Carol., XIV, pp. 245-284.
1837 Chelonites Burmeister, H., Handbuch der Naturgeschichte, Berlin, Abt. II, p. 730.
1839 Chelonides Swainson, W., The Natural History of Fishes, Amphibians and Reptiles, 1838-1839, In Lardner's Cabinet Cyclopaedia, Vol. II, p. 112.
1845 Testudinea Gravenhorst, J.L.C., Das Thiereich nach den Verwandtschaften und Uebergangen, Breslau, p. 45.
1849 Tylopoda Mayer, F.J.C., System des Thierriches oder Eintheilung das Thiers nach einem Principe, Verh. Naturh. Ver. preuss. Rheinl., VI, pp. 169-210.

History of Use. The ordinal name was seldom used prior to 1822 and in the few cases where it was, Chelonia was adopted. After the publication of Bell's monograph on the order (1842, Monograph Testudinata), in which he used the name Testudinata, this name began to compete for usage with Chelonia (Table I). Thus during the end of the nineteenth century the names, Testudinata and Chelonia, were in use. Boulenger (1889, *op. cit.*) used Chelonia, but it is doubted by the present author whether Boulenger knew of the first use of Testudines by Linnaeus and later Batsch. Boulenger derived the name Chelonia apparently from the work of Brongniart (1800, Bull. Soc. Philom.) who, like Cuvier, (*supra cit.*) used the French vernacular "les cheloniens." During the early nineteenth century many French publications which used the French vernacular name for the order had a regular stem, "Chelon," whereas the terminations were variable.

During the early part of this century the use of Testudines has increased and its use, as that of Chelonia and Testudinata, may be described as having a definite geographical distribution. Most workers in the United States have used Testudinata; those in Germany, Austria and a few other countries, Testudines; whereas in Britain, France and lands formerly under British and French sovereignty Chelonia has commonly been used with an increasing tendency now to use either Testudinata or Testudines.

Approximate percentages from 107 works and findings are tabulated in Table I. Not all zoological works have been included in this census, but only those where the author has shown interest in taxonomy and has given evidence, such as is afforded by lists of synonyms, etc., that he was aware of earlier works and has not relied entirely on other workers' opinions.

Table I. Ordinal names used for the order in 107 taxonomic works.

	Pre 1889	1890-1925	1926-40	1941-55
Chelonia	85	19	10	1
Testudinata	10	61	49	46
Testudines	2	20	41	53

Merits. The preferences and objections for the use of these names,

as have come to the attention of the present author are summarized below.

(1) Chelonia. (*a*) Objected to because of its similarity and past confusion with the Genus Chelonia within this order. (*b*) the continual decline in the use of Chelonia during the past fifteen years. Most textbooks are stable in the use of Chelonia because general textbook authors are seldom able to investigate the merits of all terminology employed.

(2) Testudinata. (*a*) Used in preference to Testudines due to the confusion claimed by Stejneger (1907) by the use of Testudines (see 3 (b)). (*b*) Objected to for being formed forty-four years after the name Testudines. (*c*) Objected to due to possible confusion with the family name Testudinidae. (*d*) Over the past hundred years Testudinata has been used more than any other ordinal name. During recent years its use has declined because fewer papers are written by those who support its use on the grounds mentioned by Stejneger.

(3) Testudines. (*a*) Used and recommended as the ordinal name on the grounds of having been published forty-four years before Testudinata, and in being first used by Linnaeus in 1758. (*b*) Objected to as the ordinal name because it causes confusion, being the plural of the generic name, *Testudo,* the type genus.

Status under the Regles Internationales. Previous to 1953 no approved method governed the naming of orders and higher taxonomic categories, but as a result of the Copenhagen Decisions on Zoological Nomenclature (1953), it was recommended that some procedure be established. It was proposed that in the additions to the Rules an "Order/Class Group" should be included and that the method employed in naming of higher groups be defined by the type method. It was also proposed to publish official lists of approved and invalid names under "Names in the Order/Class-Group in Zoology" and "Official Indexes of Rejected and Invalid Names."

An application was submitted in January, 1956, to the International Commission of Zoological Nomenclature, to vote on the validation of either Testudinata or Testudines as the ordinal name. The other names, including Chelonia (see List of Synonyms), were requested to be placed in the Indexes of Rejected and Invalid Names. Clearly Testudines had priority over Testudinata in that it was published earlier. The only objection which can be raised to the adoption of the former is that it is the plural of a generic name within the order. In the opinion of the present author this objection is over-rated for even if there were some degree of confusion it is so minor that it would not justify invalidation in favour of Testudinata.

The type-family for this order, in keeping with the Copenhagen Decisions, will be Testudinidae, as first used by Gray (1825, Ann. Philos., (2) 10:193-217), and the type genus *Testudo* Linnaeus (1758) with the type species *Testudo graeca* L., first designated by Leopoldo Fitzinger (1843, Syst. Rept.).

Acknowledgements. It is a pleasure to acknowledge the kind assistance of Dr. Heinz Wermuth, Prof. Rob. Mertens, Prof. E. M. Hering and Miss Diana N. Noakes. Many other specialists have also kindly assisted by giving their opinions on the present problems.

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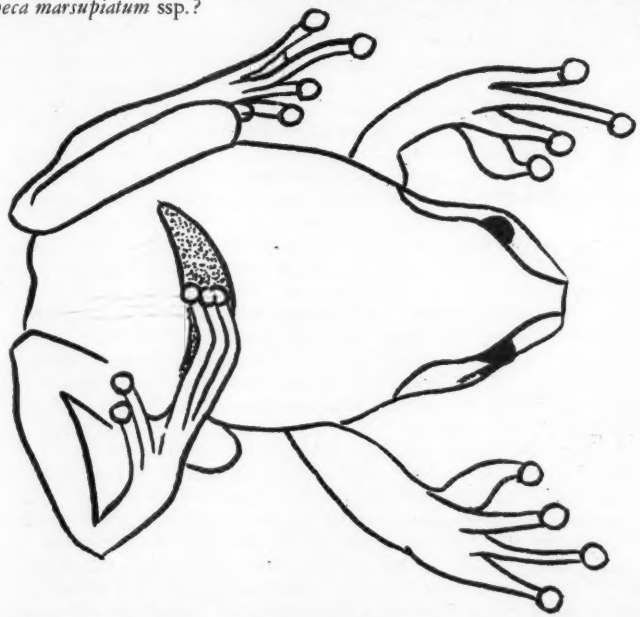
Life History of *Gastrotheca marsupiata* spp.

By STEVE GRENARD

On November 22, 1957, I received a small shipment of South American anura collected and exported by Robert Copping, in Quito, Ecuador. Included was a female Marsupial Frog, A.M.N.H. 60631, snout to vent, 50, which was sent to Dr. Charles F. Walker, Mus. of Zool., Univ. Mich., for identification. In a recent paper by J. Vellard (1957, "Estudios Sobre Batracios Andinos, Pt. 4 El Genero. Mem. Mus. Nat. Javier Prado," #5, pp. 1-47) a subspecific name, *Gastrotheca m. ecuadoriensis,* is proposed for frogs of the *marsupiatum* group in Central and Northern Ecuador. Dr. Walker does not agree that this name is valid, since Vellard gives neither a description nor designates a type specimen. I will here designate the female Marsupial frog as *Gastrotheca marsupiatum* ssp.?



While transferring her to a terrarium I noted a small black mass extruding from the narrow slit-like opening of the pouch. Upon close examination with a 10 x hand lens I observed it was a tadpole. The mother was immediately placed in a small aquarium with two inches of water. Within an hour, the birth of 94 tadpoles took place. According to Mr. John Walker (1957. "The Breeding Habits of the Frog *Gastrotheca marsupiatum*" Brit. Jour. Herpetology. Vol. 2, pp. 85-86) the birth of tadpoles identified in his paper as *marsupiatum* required 72 hours, in intervals, "8-9 were produced on the first day, 120-130 the second day and lastly 8-9 again."

The frog employed her hind limbs to stretch the opening of the pouch. (fig. 1). It was observed that many of the tadpoles were towards the side of the pouch, which extended to the dorso-lateral region; this procedure aided them to emerge. The digits of the left hind limb were inserted in the pouch and then pulled the tissue downward, if the subsequent birth occurred from that region. In a similar manner, the right hind limb and digits were employed. After completing the delivery, the opening of the pouch was fully distended and was considerably wider than before the tadpoles emerged. The mother hung limply in the water between each birth; these periods varied from ten to thirty seconds. In two instances, two pairs of tadpoles emerged connected at the mouth by tissue. After much activity for several hours both pairs became detached. Each tadpole was delivered directly into the water, either head or tail first. At birth, an average specimen measured: tail 9.3, body 5.5, total 14.8.

The larvae were raised in tap water at a constant 21°C. They were finally placed in a large aquarium with ten inches of water with a few stones protruding. The tank was fitted with a screen cover since with even some tail, the remaining transforming frogs could climb the glass. They transformed at a size of 21.9,s-v. length.

The first major secondary sex character which appeared was noticed on May 22, 1958. This was the appearance of the crescent-like slit of the pouch. The four individuals which showed the pouch measured 34, 38, 41 and 41.

Several vegetable foods and infusoria were refused, but on the suggestion of Dr. James A. Oliver I fed the larvae boiled spinach, upon which they thrived. Mr. Walker says "while in the tadpole stage, lettuce and chickweed are readily taken, and tubifex and worms are relished as soon as the legs have developed." I tried lettuce, but it seemed difficult for the larvae to feed on it. They fed quite readily on spinach until they transformed, when they accepted *tenebrio* larvae. Even though they transformed at a small size, some frogs would accept three large larvae each day. Dr. Richard G. Zweifel varied their diet by feeding them small pieces of fish dangled on the end of a pencil. They fed on the fish as well as other types of meat which Mr. Raymond Cummins of the N.Y. Zool. Park, fed in a similar manner to adults in his custody. At their present size, from 30-45 they are aggressive eaters, and are sometimes observed grabbing one another by their heads or legs, mistaking movements as food. It is interesting to note that specimens kept in warm water about 70-80°F. become sluggish and unwilling to feed, whereas others kept in a cool basement, where the temperature rarely exceeds 70°F., feed regularly.

In the larval stage, they apparently were not cannabalistic or meat eaters. When one died and fell to the bottom the others made no effort to feed upon it, preferring the spinach.

Summary. At the end of 26 days, the hind legs could readily be detected in many of the tadpoles. At the end of 45 days, the forelegs erupted, becoming large and well developed within four or five days. Most of the tadpoles were completely transformed in 56 days, although 10% required 4-7 days longer.

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Some Amphibians From Haiti and a New Subspecies of *Eleutherodactylus schmidti*

By W. Gardner Lynn

This report concerns some collections and observations made in Haiti, April 7-21, 1953, during the author's tenure as a Fulbright Scholar at the University College of the West Indies. Most of the time was spent in the vicinity of the town of Limbé which lies 12 miles east of Cap-Haitien on the Limbé River approximately 8 miles from the sea near the center of Haiti's northern coast. A few specimens were collected at other localities, notably in Christophe's Citadelle and at Diquini, a suburb of Port-au-Prince.

The student of Haitian material is fortunate in the availability of an excellent account of the herpetology of the island of Hispaniola (Cochran, 1941, USNM Bull., 177) I am grateful to Dr. Doris M. Cochran for the opportunity to examine Hispaniolan specimens in the collections of the United States National Museum and for her advice and counsel in the preparation of this paper. I am indebted to Mr. Vinton Burns and his family for their hospitality during my stay in Port-au-Prince and to my sons Richard G. and Robert W. Lynn for aid in collecting the material herein described.

Bufo güntheri Cochran

Found breeding at Limbé in mid-April. A small tributary of the Limbé River which crosses the Limbé-Cap-Haitien Road near the Baptist Seminary was completely dry in its lower reaches, but toward its source we found standing pools and running water, about a mile above the Seminary. This was our best collecting locality in this region. Here on the night of April 15 a large assemblage of toads was depositing eggs in a shallow pool 10 yards wide in the stream bed. The call, which is a guttural trill much like that of *B. marinus,* could be heard for a considerable distance. A single mating pair was preserved, but many more could have been obtained. Three others, two males and one female, were taken in an open field about three miles south of Limbé on the nights of April 11 and 13.

All males have well developed thumb pads and darkly pigmented throats. The spiny tubercles which, as Dr. Cochran has noted, are confined to the anterior portion of the back, are more prominent and more darkly pigmented in the females than in the males. In this group the two sexes also differ; only the males having a mid-dorsal light line as shown in Dr. Cochran's figure. The male of the mating pair is 74.0 mm. long, the female 94.0. The largest specimen in the U.S.N.M. is 84.0.

Hyla dominicensis (Tschudi)

Eleven adults (10 males, 1 female) and 15 tadpoles of this common species were collected. Two adults were found on the night of April 8 on the concrete walls of the spring at Turgeau on the outskirts of Port-au-Prince. The others and all the tadpoles, were taken April 13-16 along the stream above the Baptist Seminary near Limbé. The males range in length from 54.0 to 66.0, average 59.8. The female is 91.0. These are somewhat greater than the maximum lengths recorded by Dr. Cochran. All males have well-defined thumb pads and prominent vocal sacs.

This species has wide color change. Most specimens taken at night

were light gray with a tinge of greenish and with obscure darker blotches on the back. Some had yellowish blotches in groin and axilla. After capture most turned dark brown with the blotches more prominent and nearly black. In life the bones of the legs showed green through the skin. The iris was light blue except for a gold border around the pupil.

The species did not seem to be calling. Collecting this hyla was attended by an unexpected hazard in that the glandular secretion of the skin proved irritating to any small cuts or scratches.

The 15 tadpoles were taken in a small pool at the head of the stream; body lengths from 4.5 to 6.0, but most are near 5.5; average tail length 8.0; none has hind limb buds; vent is dextral; spiracle sinistral; dorsal tail fin extends onto the back for a short distance; upper labium interrupted; 2 rows of upper labial teeth and 4 lower rows.

Hyla pulchrilineata Cope

Although only 1 female and 6 males were taken, it seemed fairly common at one spot along the Seminary stream where low bushes arched over the water. Here, on the night of April 17, these little hylas were calling from leaves 2 to 8 feet above ground. The call is a rather faint clicking similar to that of *Hyla wilderi* of Jamaica which Dunn (1926, Proc. Boston Soc. Nat. Hist., V.38), aptly likened to the ticking of a tiny telegraph instrument.

The female measures 43.0; the six males are 31.0 to 33.0. Cochran (1941) says that females reach about 38 whereas males do not exceed 32. The female contains ripe ovarian eggs; the males have well developed thumb pads. Colors in life: back olive green; a mid-dorsal line of bright yellow; paired yellow lines beginning at nostrils and extending through eyes to groins; similar lines on upper lips continuing below eyes to groins; yellow lines on dorsal surfaces of all limbs; ventral surfaces white; considerable variation in the prominence of the lines, some showing all lines clearly, whereas others exhibited almost none.

Eleutherodactylus inoptatus (Barbour)

Ten taken near the Seminary stream near Limbé, April 13-15 range from 28.0 to 74.0, the largest, a female, with ripe ovarian eggs. Colors in life: back light brown with blotches of darker brown between eyes and irregularly distributed on back; dark brown bars on lower arm and upper and lower leg; sides, below glandular ridge, slate with small spots of black; black line through eye extending over and behind tympanum; loreal region light tan; groin and under surfaces of hind limbs light yellow; belly white; throat with suffusions of brown; iris brown with a dark horizontal line through the center.

We did not hear this species calling but its habit of squealing loudly when captured was exemplified by several specimens.

Eleutherodactylus poolei Cochran

Known from only type locality, the Citadel of King Christophe, near Milot. We collected two April 20 by using a flashlight in the subterranean ammunition storerooms of The Citadel. Many more were seen. These rooms are filled with piles of grape-shot and cannon balls and with masses of rifle barrels fusing together by rust. The difficult and dangerous footing and the abundance of crannies into which the frogs can duck combine to defeat the collector.

The two taken measure 21.0 and 22.0. The color pattern agrees with

that shown in Dr. Cochran's figure. In life one had a ground color of yellowish green on the back and throat with the pattern in gray, whereas the other had a light brown ground color with darker brown spots. The interocular bar was almost black in both; iris gray.

Eleutherodactylus abbotti Cochran

Five specimens were taken along the Seminary stream April 13-17. They measure 11.0, 12.0, 16.0, 17.0 and 19.0. All show the dark interocular bar, the X-shaped mark above shoulders and the black bar behind tympanum which are illustrated in Dr. Cochran's figure. In life they differed considerably in the distinctness of pattern, however, and the largest appeared almost uniform reddish brown with only the faintest indication of markings. None showed the light mid-dorsal line which Dr. Cochran reported in about half the examples she examined. Ventral surfaces were white in all.

Eleutherodactylus pictissimus Cochran

Two specimens taken from leaves close to the ground in a flower garden at Diquini, near Port-au-Prince, April 24, are assigned with some question to this species. The type of *E. pictissimus* was collected at Tardieu, Massif de la Hotte, Haiti at about 3000 feet. Up to the present the species is known from this one specimen. Diquini is approximately 100 miles west of the type locality near sea level. I have examined the type (M.C.Z. No. 19846) and find that it agrees closely with the two under consideration in all features except size. The type is 39.0 long whereas the present examples are 26.0 and 21.0. The color pattern of the larger corresponds with that of the type; the smaller is much darker, but shows the same basic pattern with light lateral stripes and interocular bar. The colors of the larger in life were: back, light tan with a pinkish cast; a dark brown blotch between eyes with a light interocular bar immediately behind it; three lines of irregular brown blotches along back; lateral lines of light tan from eye to groin; sides, below lateral lines, with two rows of irregular brown blotches; brown line along canthus extending through eye and curving down behind tympanum; upper surfaces of hind limbs with brown cross bars; yellowish cast on upper surfaces of arms and legs; belly white; throat with brown suffusions; lower surfaces of hands and feet brown.

Eleutherodactylus schmidti limbensis, new subspecies

Diagnosis. Resembles *Eleutherodactylus schmidti schmidti* Noble but with smaller adult size and shorter hind limbs, heel not extending beyond eye level when hind limbs are adpressed. The brilliant orange or red of the ventral side may be distinctive, but the colors of *E. s. schmidti* in life have not been recorded.

Type. U.S.N.M. 140166, an adult collected on a moist bank at the source of a small tributary of the Limbé River about 1.5 mi. s. of the Limbé-Cap-Haitien road where it skirts the Baie de l'Acul and about 3 miles S.W. of Limbé, Haiti, April 15, 1953, by W. G. Lynn.

Description of type. Head broader than distance from snout to occiput; snout rounded, upper jaw projecting; tongue oval, very slightly notched, its greatest width equal to about half width of mouth opening; vomerine teeth in two series, very slightly oblique, their outer borders extending to the level of outer edges of the choanae, their anterior borders separated from the choanae by a distance equal to width of choanae,

the two series almost in contact at their inner ends; nostril much nearer to tip of snout than to eye, separated from eye by a distance equal to 4/5 diameter of eye; upper eyelid without tubercles, its width equal to 2/3 interorbital width; tympanum slightly less than ½ diameter of eye, separated from eye by a distance equal to its own diameter; no webs on fingers or toes; disks of fingers and toes well developed, that of third finger 2/3 as wide as tympanum; first finger slightly shorter than second; third toe slightly longer than fifth; first toe reaching to distal border of subarticular tubercle of second toe; subarticular tubercles well developed; two metatarsal tubercles, outer about 1/3 size of inner, but well defined; no tarsal fold; heels meeting when legs are flexed with femora at right angles to body; knee and elbow just meeting when bent limbs are pressed along the sides; heel reaching to posterior edge of eye when hind limb is extended along body; skin of dorsal surface with fine reticular ridges; a very thin, raised, mid-dorsal line from snout to vent; skin of belly, throat, and ventral surfaces of limbs smooth; no external throat folds.

Dimensions of type. Tip of snout to vent, 41.5; width of head at angle of jaws, 16.0; diameter of eye, 5.0; diameter of tympanum, 2.0; foreleg from axilla to tip of longest finger, 24.0; hind leg from vent to tip of longest toe, 60.0; vent to heel, 34.5.

Color and pattern of type. In alcohol: upper surfaces drab-gray with seal-brown markings: an interorbital bar 2 mm. wide; a well-defined line from posterior border of eye arching above and behind tympanum; a broad inverted V at scapular level extending into paired irregular blotches on sides; a pair of irregular blotches at mid-body with a few smaller blotches behind these; a wide crossbar on lower arm, three well-defined crossbars on upper leg, three crossbars on lower leg with only the central one well-defined; loreal region drab-gray; seal-brown spots on upper and lower lips; anal region and posterior surfaces of thighs seal-brown; belly and throat ecru-drab with a scattering of tiny seal-brown spots on throat and chest; lower surfaces of limbs ecru-drab with small spots of seal-brown more numerous distal portions of limbs; palms of hands and soles of feet seal-brown except for slate tubercles. My field notes record that this specimen was light gray in life with the markings dark brown; the belly and ventral surfaces of all limbs deep orange; throat white; iris brown.

Variation. The paratypes (U.S.N.M. 140167-140202) exhibit a variation in tympanum size which is probably a sexually dimorphic character, the tympanum being relatively large in males, about 2/3 diameter of eye and less than ½ diameter of eye in females. There is some variation in length of the patches of vomerine teeth which extend to the level of the outer edges of the choanae in some specimens, but only to about the middle of the choanae in most. The distance between the two vomerine series may be very short, so that they are almost in contact, or wider, varying up to the width of the choana.

Paratypes range from 24.5 to 44.0; mean length of all 33.7. This obviously includes a number of immatures. The largest are females with ripe ovarian eggs showing through the body wall. Six range from 38.0 to 44.0 with a mean of 42.5. The six largest males in the collection (as sexed by tympanum size and in three cases by dissection), range from 30.0 to 36.0, mean 33.8. It appears that adult males attain about ¾ the

length of females. Measurement of femur and tibia in 37 specimens shows the length of the femur averages 45.9% and the tibia 46.4% of body length.

The preserved paratypes range from dark brown to light gray. In the very dark ones the pattern of darker markings is difficult to distinguish. All specimens, however, show the dark interocular bar with a lighter bar anterior to it and the dark line over tympanum. The inverted V on the scapulae is clearly visible on all but the darkest.

Colors in Life. In living specimens the dorsum varied from dark brown, almost black, to dirty gray with dark mottlings. All individuals had light interocular bars and nearly all showed a scapular inverted V-shaped dark marking. Some had a few scattered deep red spots on the back. The ventral side was brightly colored in all. In most cases the belly was deep orange, but in a few it was canary yellow and in a few dark red. The color extended onto the ventral surfaces of both upper and lower segments of all limbs, but stopped abruptly at the sternum and the throat was always pure white; iris brown. The ventral color faded in alcohol and disappeared completely after about two years. The dorsal colors have undergone little noticeable alteration.

Habitat. The 37 specimens were taken at night on the wall of a ravine at the source of a small stream. Water seepage kept this wall dripping over an area about 10 feet high and 40 feet long where all the frogs were found. The bank was of friable shale with many deep clefts and fissures and with a considerable growth of moss. Most of the animals were sitting at the edges of clefts and a number escaped by retreating into these. Night collecting in a number of other places in the neighborhood yielded no other examples and none was found by turning rocks in the daytime in the same locality. This is undoubtedly a moisture-loving frog, but its distribution may not be as restricted as these observations indicate. However, it does seem probable that the dissemination of this species is more dependent upon moisture than in some other eleutherodactylids such as *E. ricordi* or *E. martinicensis.*

Call. A number of the males were calling from the edges of cavities in the ravine wall when taken. The call is a single "klook."

Relationships. The two previously known subspecies of *E. schmidti* are both from the Dominican Republic. The type and paratypes of *E. schmidti schmidti* Noble were from Lo Bracita, Province Pacificador and Cochran (1941) records it from Constanza, Los Limones near Janico, and Mount Diego del Campo. *E. schmidti rucillensis* Cochran is known only from the type and a paratype taken at 4,000-7,000 feet on Loma Rucilla. Limbé, Haiti, where the present specimens were collected, is approximately 100 airline miles from the nearest of these localities. *E. s. rucillensis* is distinguished from *E. s. schmidti* chiefly by its longer hind legs. As has been pointed out, *E. s. limbensis* has considerably shorter legs than *E. s. schmidti.* Cochran (1941) records two specimens of *E. s. schmidti* 48 long and one 54. The largest specimens in the present series are 44. Since this is a series of 37 specimens it seems likely to indicate a difference in adult size between these two subspecies. The two known specimens of *E. s. rucillensis* fall in the size range of *limbensis* measuring 41 and 35.

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A New Race of *Desmognathus Fuscus* From the South-Central United States

By DOUGLAS A. ROSSMAN

Recent investigations of the dusky salamanders of southern Illinois, western Kentucky and western Tennessee have revealed a distinctively marked form which is presently unrecognized. For this colorful race of salamanders I propose the name

Desmognathus fuscus conanti[1], subsp. nov.

Spotted Dusky Salamander

Holotype. AMNH, No. 62223, adult female, Douglas A. Rossman and Nita Jane Rossman, July 28, 1957, 400 feet el., near U. S. Highway 60, 2.1 mi. S Smithland, Livingston Co., Ky.

Paratypes. AMNH, Nos. 62224-62227. Acad. Nat. Sci. Philadelphia, No. 26564 (5). Personal collection of Douglas A. Rossman, Nos. 803, 859-863, 950-954. All paratypes collected with holotype.

Diagnosis. A moderately large *Desmognathus* characterized by: loss of vomerine teeth in large adult males; possession of enlarged and recurved premaxillary teeth in adult males; tail moderately keeled; venter light but mottled; six to eight pairs of golden or reddish-gold dorsal spots, usually separate, but occasionally partially fused to form a dorsal band with deeply serrate margins; prominent postocular bar yellow or orange.

Description of Holotype. Snout rounded; sides of head from anterior corner of eye to angle of jaw curved, not parallel; cheeks only moderately swollen; short vertical groove from angle of jaw to sinuous groove extending from eye to vertical extension of gular fold; body broadly rounded and dorso-ventrally flattened; tail subquadrate at base, posteriorly becoming slightly keeled above and rounded below; legs stout; toes of forefeet, 1-4-2-3 in order of length from shortest to longest, hindfeet 1-5-2-4-3; webbing between toes barely evident; vent with narrow, raised margin, oblique folds internally; costal grooves 14, including one in axilla and two converging in groin; 4½ intercostal folds between toes of appressed limbs; vomerine teeth in 2 series of 10 each, separate from each other and from parasphenoid teeth which are in 2 elongate, club-shaped patches separated posteriorly, but converging anteriorly.

Tip of snout to posterior angle of vent 51 mm.; tail, 53; total, 104; head length, 12.4; head width, 7.7.

Dorsum with 8 pairs of large, elongate reddish-gold spots, slightly obscured by suffusion of dark pigment from sides; 3 anterior spots on either side of midline fused, others entirely separate; spots margined with black; top of head brownish; bright orange postocular bar (larger than eye) from posterior angle of eye to angle of jaw; upper sides and legs grayish-brown, becoming mottled on lower sides which have a row of white spots from axilla to groin; venter relatively light, irregularly pigmented with black stellate flecks giving mottled effect; unpigmented around vent; dorsal tail-band reddish-gold, serrate anteriorly; ventral surface of tail more uniformly dark posteriorly.

Variation. There are 7 pairs of dorsal spots in 15 paratypes, 8 pairs

[1]Named for Mr. Roger Conant, Zoological Society of Philadelphia, in recognition of his contributions to herpetology.

in 5. Spots vary in size, shape and proximity to each other. They may tend to fuse longitudinally and across the middorsal line to form a deeply serrate dorsal band or all spots may be separate. Spots may be obscured to varying degrees by suffusion of pigment from the upper sides, but are always discernible. They are yellowish-tan, chestnut brown, golden brown, reddish-gold, gold, reddish-orange or blood red in life. Tail bands are the same colors as spots and are serrate or straight-edged. Color of upper side varies from tan through grayish brown to charcoal gray; lower side frequently mottled with black and white; a row of white spots from axilla to groin usually present although varying in prominence. Four specimens also have a row of white spots on the tail. Top of head tan varying through chestnut brown to dark brown; postocular bar prominent in 90%, reddish-orange through yellow to gold; not infrequently a light naso-labial line present; the degree of ventral mottling varies greatly, but none has a uniformly pigmented venter. One has a very dark venter. In life venters are mottled with black and white, or gold, stellate flecks. The white and gold disappears after a few months in preservative. Sub-adults are similar to adults in color and pattern, differing chiefly in more distinct spots and a large gold spot on venter at level of heart.

All have 14 costal grooves. Intercostal folds between toes of appressed limbs vary from 2½ to 6 (mean 4), the largest not necessarily possessing the larger number; vomerine teeth lacking in large adult males; largest male with vomerine teeth 54 snout-vent; smallest adult that lacks vomerine teeth 50 snout-vent. When present, the number of teeth in males varies from 5 to 11 (mean 7.4); in females from 9 to 20 (mean 13.4); vent in adult males papillate, the testes uniformly pigmented black.

Dimensions. Total length of smallest transformed individual, 35, largest, 114. Twenty sexually mature adults with complete tails 76-114 (mean 96.4). Snout-vent of 19 females 50.0 (43-60), 8 males 48.1 (40-58). Head length of 16 females 12.0 (10.4-14.0), 5 males 11.8 (10.2-13.7). Head width of 16 females 7.7 (6.9-8.3), 5 males 7.4 (6.3-8.5). Tail length/total length ratio of 15 females 49.7% (46.8-52.2), 5 males 50.1% (47.4-52.2).

Comparisons. Large size and moderately keeled tail exclude *conanti* from the pygmy races of *Desmognathus.* Loss of vomerine teeth in large adult males and a tendency in some individuals toward fusion of dorsal spots into a dorsal band indicate that *conanti* is a race of *fuscus* rather than of *monticola.* It need, therefore, be compared only with the other races of *fuscus.*

D. f. conanti differs from *D. f. carri* in being larger [maximum snout-vent measurements; *conanti* 66, *carri* 38 (Neill, p. 25)], and in its greater number of paired dorsal spots [*conanti* 7-8, *carri* 5-6 (Neill, p. 27)]. From *auriculatus* it may be distinguished by a brightly marked dorsum, more prominent postocular bar and absence of black venter or dorsum. It is smaller than *welteri* [maximum snout-vent measurements: *conanti* 66, *welteri* 89 (Barbour and Hays, p. 354)], has a heavily mottled venter, brightly marked rather than mottled dorsum and more prominent postocular bar.

From *brimleyorum* it differs in being smaller [maximum snout-vent

measurements: *conanti* 66, *brimleyorum* 82 (Dunn, p. 104)], having longer tail in relation to body length (tail/total ratio more than 46% in *conanti,* less than 46% in *brimleyorum*), brightly marked dorsum, and no prominent row of white spots on tail. From *fuscus,* which it most closely resembles in body proportions, it differs in mottled venter and limbs (*fuscus* usually has large unpigmented areas), in bright, prominent postocular bar (*fuscus* usually has but narrow whitish line), retention of dorsal spots which only partially fuse (*fuscus* usually loses spots soon after transformation and margin of dorsal band is rarely deeply serrate), absence of large dark spots in dorsal band, and absence of melanistic individuals.

Range. Conanti occupies western Kentucky and western Tennessee east of the Mississippi River alluvial plain, west of the range of *fuscus* (Grobman, p. 5) and south and west of *welteri* (Barbour and Hays, p. 356). Its range south of Tennessee is imperfectly understood and is being investigated. There is some indication that *conanti* may range through eastern Mississippi and Alabama into western Florida. The outlying population in southern Illinois shows some evidence of previous contact and intergradation with *fuscus* in Indiana. Illinois specimens although tending toward *fuscus* in some features cannot be considered intergrades and are assignable to *conanti.*

Specimens Examined. ILLINOIS: Pulaski Co.—2 mi. NE Olmsted (DAR 597-600, 637-643, 901-945). KENTUCKY: Livingston Co.—2.1 mi. S Smithland (AMNH 62223-62227, ANSP 26564 (5), DAR 803, 859-883, 950-954, 33 specimens from collection of James C. List). TENNESSEE: Cheatham Co.—4 mi. NW Joelton (DAR 790-796); Chester Co.—6.5 mi. W Henderson (DAR 786-788); Dickson Co.—3.3 mi. NE Charlotte (DAR 841-843), 2 mi. E Charlotte (CAS 13203-13207, 14683-14685, 13330), 0.6 mi. NE Charlotte (DAR 819-823); Hardeman Co.—10 mi. NE Bolivar (CAS 13113-13114).

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LITERATURE CITED

Barbour, Roger W. and Rodney M. Hays. 1957. The genus *Desmognathus* in Kentucky. I. *Desmognathus fuscus welteri* Barbour. Amer. Midl. Nat., 58(2): 352-359.

Dunn, E. R. 1926 The salamanders of the family Plethodontidae. Smith College 50th Anniversary Publications, 441 pp.

Grobman, Arnold B. 1950 The distribution of the races of *Desmognathus fuscus* in the southern states. Chicago Acad. Sci., Nat. Hist. Misc., no. 70: 1-8.

Neill, Wilfred T. 1951 A new subspecies of dusky salamander, genus *Desmognathus,* from south-central Florida. Pub. Research Div. Ross Allen's Rept. Inst., 1(3): 25-38.

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Observations on Preferred Body Temperature and Feeding Habits of Some Selected Tropical Iguanas

By DANIEL C. WILHOFT

Very little data appears in the literature on the temperature preferences of tropical forms. Considered here as tropical are forms occurring within 23 degrees of the equator, and in areas of minimum fluctuations in daily and seasonal temperature. Reptiles in the tropics where such factors as altitude, vegetation, and amount of precipitation cause major fluctuations in daily or seasonal temperatures is not here considered "tropical." Herter (1940) described the preferred substrate temperatures for *Agama stellio,* a form which closely approaches the tropics geographically, but did not record body temperatures. As pointed out by Bogert (1949a: 203) Herter's findings are one-sided in relation to preferred body temperatures. He further points out that preferred substrate temperature is by no means the same as preferred body temperature, which is referred to throughout this paper. Bogert (1949b) reported eccritic or preferred body temperatures for the genus *Sceloporus* at 14 degrees N. latitude in Honduras, a locality well within the tropics.

Through the generosity of the San Francisco Zoological Society and Dr. Robert Bowman, I received seven live lizards from the Galapagos Islands (approximately 0 degrees latitude) including two adult land iguanas (*Conolophus pallidus*) weighing 2.1 and 1.8 kg., one juvenile land iguana weighing 35.0 gm., one adult marine iguana (*Amblyrhynchus cristatus*) weighing 3 kg., and three juvenile marine iguanas weighing 119.5, 144.0, and 160.0 gm. The land iguanas were collected on Barrington Island and the marine iguanas from Indefatigable Island.

Current interest in the factors which might influence thermoregulation in Temperate Zone ectotherms provided the stimulus to ascertain the temperature and light preferences of these tropical forms. Temperate Zone ectotherms are greatly affected by extremes in environmental conditions and have developed behavioral patterns to survive them. Hibernation and estivation are the most striking, but duration of daily activity, although not as often observed, is equally important in avoiding excess of temperature. Whether these daily activity patterns could be observed in tropical ectotherms in captivity, was another reason for making these observations. Also of interest was the feeding of these iguanas.

The thermal preferences of these iguanas were ascertained by recording their body temperatures when they were placed in thermal gradients in the laboratory. The juveniles of both species, because of their smaller size and compatibility, were placed together in a photothermal gradient which was a modification of one used by Stebbins (1958) in testing temperature preferences of *Sphenodon.* It consisted of a dark runway and also a runway provided with a step-wise illumination gradient. Openings permitted movements between runways. The lighted runway consisted of four compartments separated by wood partitions, except near the floor where a canvas curtain allowed movement between compartments. The cool end of the first compartment was kept almost completely dark (0.8 Weston Light Meter reading); illumination in the next three chambers was 50, 200, and 800 Weston Light Meter readings respectively. A thermal gradient of from 3 to 5 degrees C. (all temperatures in C.) at

the heated end was maintained continuously in the lighted runway, whereas a gradient from 3 to 5 at the cool end, to 45 was maintained in the dark runways. Body temperatures were taken of adults and juveniles with a quick recording Schultheis, 0-50 degrees thermometer inserted into the cloaca and recorded at least once for every hour of the day and night for three weeks. After each body temperature was recorded, the animal was returned to the cool end of the gradient, where it usually remained only momentarily before returning to its preferred location in the gradient. When the temperatures were taken, the position of the animal in relation to the light was recorded. After over 100 records of body temperature for each animal were obtained, the gradient was altered so that the compartment which was found to be preferred for heat and light, was reduced in light intensity from 200 to 3.2 and in an adjoining compartment it was increased from 50 to 200. The temperature of the compartments was not changed. This adjustment placed the preferred temperature compartment in subdued light and the adjoining compartment, although in bright light, at approximately 10 degrees below what had been found to be the preferred body temperature of juvenile marine and land iguanas. This was done to ascertain the importance of light in determining where the animals would spend most of their time.

The adult iguanas were placed in a cage 4 x 10 ft. provided with a thermal gradient, but with only a moderate light gradient. The heated end was maintained at 45 whereas the unheated end varied between 20-25. The cage received light through windows, but at night it was dark, except for subdued light from the heating elements and infrared light bulbs, at the heated end. Body temperatures and positions were recorded for the marine and two land iguanas at least once for every hour, day and night for three weeks.

The preferred body temperatures recorded were as follows: *Amblyrhynchus,* adult, 31.4 $\pm$ .341; juveniles, 33.6 $\pm$ .189, 33.7 $\pm$ .103, 32.4 $\pm$ .176; *Conolophus,* adult, 33.5 $\pm$ .167, 33.0 $\pm$ .193; juvenile, 34.8 $\pm$ .169. The variation between the mean body temperatures of the seven animals is slight, range 31.4-34.8 degrees. One juvenile which refused to feed and died within two weeks and the adult marine iguana which did not feed, both exhibited a slight (approximately 1.6 and 1.3 degrees) deviation from the means of other lizards, juvenile *Conolophis* excepted. In both it was observed that they increasingly tended to remain at the cooler ends of the gradients, accounting for their one to two degree lower mean temperature. With the exception of these two and the juvenile land iguana, which maintained a slightly higher body temperature (mean 34.8), there seems to be little difference in the mean temperature between land and marine types, based on this small sample. Another observation is that the average mean temperature is approximately 1.5 degrees less than the average preferred 35 degrees of a Temperate Zone iguanid *Sceloporus occidentalis* (Wilhoft, 1958). The most striking feature of the thermal behavior seems to be the tendency to remain day and night at one preferred temperature in the gradient. They thus experienced a narrow range of temperature fluctuation. Many Temperate

Zone lizards have optimal temperatures* near that of endotherms, but the environment has been regarded as the prime factor which restricts their full use of such temperatures. However, both laboratory and field observations reveal that lizards which seek cover during periods of optimal temperatures are voluntarily restricting the use of optimal temperatures, even though the environment would permit longer periods of exposure at higher temperatures. This suggests that there is not only an optimal temperature *level* but also an optimal amount of *exposure* to such levels (Stebbins and Eakin, 1958). The tendency of captives to avoid overexposure to optimal temperatures has been observed (Stebbins, unpublished data) to become less pronounced with the passing of time and they were found to have developed elevated thyroid epithelia. It has also been demonstrated by Wilhoft (*op. cit.*) that *Sceloporus occidentalis* kept at a constant temperature, approximating the average normal activity range for at least thirteen weeks, displays thyroid hypertrophy and hyperplasia. A high percentage of deaths results from this exposure despite the fact that the lizards were well fed and watered.

These limited observations on two types of Tropical Zone iguanas suggest that since they did not exhibit any avoidance behavior, they have a much narrower preferred range of body temperature than Temperate Zone iguanids, or that under conditions of captivity they were engaging in excessive exposure to heat. Lack (1949) reports that although many equatorial regions have a hot and damp climate, with a double rainy season, the Galapagos Islands are an exception due to the Humboldt current. Yearly temperatures are cooler than in many other areas in the tropics (daily maximum between 60 and 70 degrees F. and a cool dry season (May-Dec.) accompanied by fog, is followed by a rainy season (Jan.-Apr.). Dr. Robert Bowman (personal communication) has observed that both these Galapagos lizards seek cover at night, much like Temperate Zone forms, and it must be assumed that their body temperature sometime during this period falls below the normal mean encountered during basking by day. If there is a noticeable difference in environmental temperature between night and day on the islands and the lizards are observed to seek cover, their behavior in the laboratory of remaining exposed at one preferred location day and night, might be an indication of their trying to maintain the preferred body temperature for prolonged periods when available. This behavior did not appear to have any adverse effect on survival as was observed for one Temperate Zone form. Whether or not any changes in the thyroid took place was not ascertained.

After over one hundred records each of body temperatures were secured for the juveniles, the gradient was altered so that the compartment which was found to be preferred, for both heat and light, was reduced in light intensity from 200 to 3.2 and in an adjoining compartment the light was increased from 50 to 200. Observations were recorded before and after this change as to how much time was spent in a given location in the runway. The results indicate that one lizard did shift

*The optimal body temperature has been defined (Wilhoft, op. cit.) as the range of temperature found in individuals which are voluntarily active on the surface of the ground. Excluded are those animals which have emerged recently and are in the process of warming up.

towards greater illumination and less heat, two did not shift position, and one died before this phase of the experiment. One lizard (marine type) showed a greater tendency to remain in an area of reduced heat and strong illumination than either of the other two. One which died before the change showed a greater tendency to remain in an area of reduced heat (and less illumination) than any of the other three. The lizard which seemed to prefer reduced heat and strong illumination remained in good condition during the entire period of the experiment. It is therefore hard to explain this lizard's preference for increased light and reduced heat in terms of poor physical condition or starvation, as is possible for the one that died and the adult marine iguana. Although this experiment is by no means conclusive, it suggests that temperature rather than light is the more important factor in orientation in a photothermal gradient. In Temperate Zone iguanids, temperature is more important than light in regulating daily activity due to extreme environmental temperature fluctuations, but in tropical environments where there may be slight fluctuations in ambient temperature, light may become more important, especially in stimulating animals to seek cover at night.

The lizards were given a varied diet every other day. Fresh water was always available in addition to a pan of salt water that was provided should the marine iguanas be inclined to enter it. None was observed to enter this salt water, although they drank fresh water freely. Although marine iguanas have been kept in captivity before, there seems to be no reports of success in feeding them for extended periods. Our adult marine iguana refused to eat although various seaweeds and algae, numerous vegetables, fruits, meat and young, live, hairless rats were offered. The juvenile marine iguanas (except one that was received in poor condition and ate poorly) ate well and gained weight. They eat fish (cooked mackerel), ground beef and an occasional banana and greens. Young, hairless rats were always killed and often eaten. The adult and juvenile land iguanas fed well. The juvenile ate bananas, lettuce, mealworms (larvae of *Tenebrio molitor*) and apples, whereas the adults took almost any vegetable or fruit and an occasional small amount of ground beef. In an effort to supplement the diet, cod liver oil was placed on their food, but food so treated was refused.

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LITERATURE CITED

Bogert, C. M. 1949a. Thermoregulation in Reptiles, A Factor in Evolution. Evolution, 3(3): 195-211. 1949b. Thermoregulation and Eccritic Body Temperatures in Mexican Lizards of the Genus *Sceloporus*. Anales del Instituto de Biologia, Tomo xx Nos. 1 y 2.

Herter, K. 1940. Uber Vorzugstemperaturen von Reptilien. Z. vgl. Physiol., 28: 105-141.

Lack, D. 1950. Breeding Seasons in the Galapagos. Ibis, 12: 268-278.

Stebbins, R. C. 1958. An Experimental Study of the "Third Eye" of the Tuatara. Copeia, (in press).

Wilhoft, D. C. 1958. The Effect of Temperature on Thyroid Histology and Survival in the Lizard *Sceloporus occidentalis*. Copeia, (in press).

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On the Validity of *Taricha Granulosa* Skilton*

By RICHARD A. PIMENTEL

It is the purpose of this paper to indicate the presence of *torosa* characters in *granulosa,* to ascertain the difficulty they present in diagnosis by indicating their prevalence, and to comment on their significance. This study questions the validity of specific distinction of *granulosa* from *torosa.*

In 1946, the author was willing to accept the specific status of *Taricha rivularis,* a form that still seems valid, but questioned the distinction between the other two species of the genus, *torosa* and *granulosa.* Specific distinction of the latter two was first questioned because of the difficulty in keying preserved specimens of these two forms to the proper species. Added support to this impression of invalidity was gained from a field trip in the vicinity of Los Gatos, Santa Clara Co., Calif. At this time a mass migration of male newts was observed. Although the newts probably were all *granulosa,* many keyed to *torosa.*

Detailed studies in the vicinity of Corvallis, Benton Co., Oregon, and elsewhere in western Oregon further convinced the author that the diagnostic criteria for *granulosa* are not always reliable. Perhaps this lack of character reliability is the reason for *granulosa* having been placed in the synonomy of *torosa* for so many years. Skilton (1849) described *granulosa* but it was considered a *torosa* synonym by major workers on *Taricha* (Ritter, 1897; Chandler, 1918; Storer, 1925; and Selvin, 1928) until 1935. Chandler accepted the synonomy of *granulosa* but pointed out important biological differences from *torosa.* These differences caused Chandler to suspect two subspecies of *torosa.* Twitty (1935) considered *granulosa* a valid species when he described *Triturus simulans; simulans,* now considered a subspecies of *granulosa,* was placed in the synonomy of *granulosa* by Fitch (1938). From 1935 to the present *granulosa* has been considered a distinct species.

Twitty (1942) and Stebbins (1951) summarize how *granulosa* differs from *torosa:* (1) jaw margin extends laterally below the eye, so that it is not visible in free profile, instead of a projecting eye partly concealing the jaw margin; (2) snout blunter; (3) eye smaller; (4) vomerine teeth approximately in relationship of the two arms of an inverted letter V, whereas in the other species they lie almost parallel in their anterior extent, followed by an abrupt divergence posteriorly; (5) female cloaca lips form an elevated, somewhat laterally compressed cone, with the small vent situated near the apex, instead of longer and situated deeper between the more swollen lateral lips; (6) breeding male tail fin reaches an extreme degree of development compared with the other species; (7) sharper demarcation along the sides where the darker pigment of the back meets the lighter coloration of the belly; (8) iris lighter than *T. t. torosa* but similar to *T. t. sierrae;* (9) eggs usually laid singly; and, (10) usually frequents permanent, quieter water. Stebbins later (1954) added another character, "light color when present

*Based on part of the work done in fulfillment of the requirements for the degree of Doctor of Philosophy in Zoology, Oregon State College. The author wishes to express his gratitude for the guidance of Dr. Robert M. Storm and the aid of others mentioned in this paper.

on upper jaw does not reach lower eyelid," instead of: "light color of upper jaw extends onto lower eyelid." Stebbins also states that the latter characteristic's use is limited to where *granulosa* and *torosa* occur together.

For this investigation a sample of 50 male and 50 female *granulosa* was obtained from Peavy Arboretum Pond, about seven miles north of Corvallis. The study is limited to characters (1), (2), (4), (5) and (7) of the previous paragraph. Smaller eyes, (3), was eliminated when a sample of five male and five female *torosa* showed no significant difference from a like sample of *granulosa* in a 2x2 factorial analysis. Although these samples were small a uniformity trial indicated the sample sizes as being more than adequate to differentiate a "key character." Breeding male tail fin, character (6), was eliminated because it is subject to seasonal variation. Although such a fine difference probably exists it cannot be measured accurately (Pimentel, 1952). This iris color character, (8), was eliminated because it approximates that of *T. t. sierrae*. Character (9), eggs usually laid singly, is excellent but of limited use. Although the author found as many as four *granulosa* eggs in a cluster, probably more than 99% of egg depositions are of single eggs. Even *granulosa* clusters are distinct because *torosa* probably does not lay fewer than seven eggs in a cluster (Stebbins, 1954). Character (10) on habitat separation is an excellent, but not an absolute, character.

Preliminary study convinced the author that there is no sharp *torosa-granulosa* demarcation in any of the four characters being considered. Because of the lack of sharp character distinction and concern about the possibility of personal bias, it was considered desirable to obtain the opinions of others. To obtain these opinions camera lucida drawings were made of head characters (Pimentel, 1952). The individual opinions of Drs. Aryan I. Roest, Donald G. Dunlap and Philip C. Dumas, then fellow graduate students, and Dr. Robert M. Storm, then major professor, in comparing the 100 camera lucida drawings of 50 males and 50 females with published illustrations (Twitty, 1935) of *granulosa* and *torosa* were obtained. Differences in these opinions were almost non-existant. Consultation with Dr. Storm resulted in the present interpretation.

The four characters are designated as follows: (1) eye, (2) snout, (4) teeth, and (7) color. The presence of *torosa* characters are indicated in the form of a fraction, male characters for the numerator and female characters for the denominator. The number given for each sex enumerates the total of fifty individuals possessing *torosa* characters. Ignoring the cloaca character to compare males/females for the number of *torosa* characters we obtain the following: none 21/18, one 17/24, two 10/3, three 2/5 and four 0/0. The two males with three characters had teeth-eyes-snout and teeth-eyes-color. Of the five females with three characters two had teeth-eyes-snout, two had teeth-eyes-color and one teeth-color-snout. The ten males with two characters consisted of one teeth-eyes, five teeth-color, one teeth-snout, two eyes-color and one eyes-snout. The three females with two characters were distributed one each in eyes-color, eyes-snout and color-snout.

To investigate the possibility of sexual dimorphism these characters are regrouped on an individual basis for males and females. The following number of male/female *torosa* characters prevail: teeth 14/15, eyes 6/11, color 15/7 and snout 8/12. Ten females had cloacas more

typical of *torosa*. Although this subdivision of the data results in small samples for statistical comparison, Chi-squared values are so low as to discourage further consideration of sexual differences. The assumption of a lack of sexual dimorphism is further supported by summing the total male-female *torosa* characters, 43/45.

To summarize, stated as means with 95% confidence limits of the means, 39% (29-49%) of the *Taricha granulosa* are "pure" for *granulosa* characters, 41% (31-51%) have one, 13% (7-21%) have two, and 7% (3-14%) have three of four *torosa* characters. *Granulosa* shows no sexual dimorphism in the *torosa* characters.

Discussion

Until recently *granulosa* was considered to be the ancestor of western *Taricha* but von Wahlert (1952) gives strong biological evidence for the separation of *granulosa* from *torosa*-like ancestors. It is believed that the data presented in this paper support von Wahlert's ideas and further indicate that the dichotomy was primarily along physiological lines.

The problem remains to determine if the biological differences, other than morphological, are sufficient to consider both *torosa* and *granulosa* valid species. Naturally this is necessary because morphological similarity, even seeming identity, of two or more valid species is known in other groups of organisms. One biological difference is laying single eggs as opposed to seven or more eggs in a cluster. This, however, does not seem an important difference when we find certain subspecies of *Ambystoma tigrinum* depositing single eggs and others clusters of over 100 (Stebbins, 1954; Bishop, 1943). The second major biological difference has to do with habitat preference. *Granulosa* prefers to breed in quieter, more permanent bodies of water and stays in the breeding habitat longer than *torosa*. Also, *granulosa* is found principally in the transition and lower boreal life zones and *torosa* in upper sonoran and transition life zones. This difference is of minor importance because many examples could be given of different geographic races of a species occupying different habitats. An additional criterion for specific separation of the two forms, perhaps the most important reason for present opinions on the status of the two forms, is found in geographic range (Stebbins, 1951, 1954). According to present taxonomic relationships, *torosa* overlaps the ranges of two subspecies of *granulosa, simulans* and *twittyi*. Also, there are only a few localities where *torosa* and *granulosa* are known to occur together. In these areas hybridization does occur (Stebbins, 1954). As yet there has been no evidence to indicate lack of viability of these hybrids. In fact Twitty (1936) indicates no difficulty with laboratory produced hybrids of any combination of *rivularis, torosa* and *granulosa*. Herein lies the crux of the problem. Hybridization suggests one species, but the geographic range presents difficulties when considering *torosa* and *granulosa* to be races of a single species. If there were no like situation of range overlap with habitat separations and a minimum of intergradation, the evidence for such a relationship might still be questioned. However, such a situation, on a more complex level, does occur in the *Thamnophis elegans* rassenkreis in western North America (Fitch, 1940; Fox 1951).

Although it might be possible for *torosa* and *granulosa* to be two species, present evidence would indicate them to be groups within a single

species. Stebbins (1951) questions the validity of *twittyi* and *simulans*, but the author has insufficient evidence to consider their status.

On the basis of the foregoing discussion the genus *Taricha* would be subdivided as follows:

Taricha torosa torosa Rathke
Taricha torosa sierrae Twitty
Taricha torosa granulosa Skilton
Taricha torosa mazamae Myers
Taricha torosa twittyi Bishop
Taricha torosa simulans Twitty
Taricha rivularis Twitty

LITERATURE CITED

Bishop, S. C. 1943. Handbook of salamanders. Comstock Publ. Co. 555p.

Chandler, A. C. 1918. The western newt or water-dog (*Notophthalmus torosus*) a natural enemy of mosquitoes. Oregon Agr. Col. Exp. Sta. Bull., 152:1-24.

Fitch, H. S. 1938. An older name for *Triturus simulans* Twitty. Copeia, 1938:148-149.

———1940. A biogeographical study of the *ordinoides* artenkreis of garter snakes (genus *Thamnophis*). Univ. Calif. Publ. Zool., 44:1-150.

Fox, Wade, 1951. Relationships among the garter snakes of the *Thamnophis elegans* rassenkreis. Univ. Calif. Publ. Zool., 50:485-530.

Pimentel, R. A. 1952. Studies on the biology of *Triturus granulosus* Skilton. Ph.D. Thesis, Oregon State College. 128p.

Ritter, W. E. 1897. *Diemyctylus torosus* Esch. The life history and habits of the Pacific Coast newt. Proc. Cal. Acad. Sci., Zool., 1:73-114.

Skilton, A. J. 1849. Description of two new reptiles from Oregon. Amer. Jour. Sci. Arts. 2:202.

Slevin, J. R. 1928. The amphibians of western North America. Occ. Pap. Cal. Acad. Sci., 16:1-152.

Stebbins, R. C. 1951. Amphibians of western North America. Univ. Calif. Press. 539p.

——— 1954. Amphibians and reptiles of western North America. McGraw-Hill Book Co. 528p.

Storer, T. I. 1925. A synopsis of the Amphibia of California. Univ. Calif. Publ. Zool., 27:1-342.

Twitty, V. C. 1935. Two new species of *Triturus* from California. Copeia, 1935:73-80.

———— 1936. Correlated genetic and embryological experiments on *Triturus*. I and II. J. Exp. Zool., 74:239-302.

———— 1942. The species of California *Triturus*. Copeia, 1942:65-76.

von Wahlert, G. 1952. On the systematic position of the salamandrid genus *Taricha* and its species. Copeia, 1952:29-30.

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SOUTHERN OCCURENCE OF THE SHARP-TAILED SNAKE IN A UNIQUE COMMUNITY.—The southern part of the range of *Contia tenuis* (Baird and Girard), has the appearance of a horseshoe, one arm extending down the Sierra Nevada and the other down the Coast Ranges. Van Denburgh (The Reptiles of Western North America. 1922, p. 773) gives the southern coastal limit of the Sharp-tailed Snake as Carmel, Monterey Co., California. Wright and Wright (Handbook of Snakes. 1957, p. 156) indicate this on a distribution map as the southern coastal limit of the range. Also on a distribution map, Stebbins (Amphibians and Reptiles of Western North America. 1954, p. 490) places the southern coastal limit in the vicinity of latitude 36° N. Stebbins may have been following accepted procedure in indicating the range beyond recorded localities.

On May 16, 1958, the author took a 263 mm. total length, male *tenuis* less than one-fourth mile south of the summit of Pine Mountain (6 miles ENE of San Simeon), elevation 3954 feet, San Luis Obispo Co., California, where the annual rainfall exceeds 100 inches. Despite the much greater precipitation on Pine Mountain than on the adjacent coastal lowlands, Pine Mountain dries out much more rapidly. This record is about seventy airline miles south of Carmel and twenty-five south of latitude 36° N. This record places the species in San Luis Obispo Co. and changes the southern limit from the Sierras to the Coast Ranges.

The snake was found in what appeared to be a mouse burrow under a partially embeded oak log in a sparse cover of herbaceous plants at the edge of a grass meadow. The ground under the log was extremely dry to a depth of at least six inches. Dryness of the area was indicated further by the near absence of green herbs in the meadow. Fifteen feet away was a small stream bordered by Maul Oak (*Quercus chrysolepis*), Madrone (*Arbutus menziesii*), Toyon (*Photinia arbutifolia*) and Blue Elderberry (*Sambucus coerulea*). The stream bed was about four feet wide and contained a few pools of water. A barely perceptible seepage was observed in other areas of the stream.

Two things cause Pine Mountain to be unique, its geology and the assemblage of plants found there. Geologically, most of the Coast Ranges are composed of Jurassic sedimentary, volcanic and intrusive rocks and Cretaceous serpentine. Pine Mountain is composed of Tertiary intrusives but is surrounded by Cretaceous sedimentary and a limited amount of the "typical" Coast Ranges rocks. The geology, therefore, presents a substrate that is uncommon. The plant community, a relict community, seems particularly unique. This is partially indicated by the assemblage of many species of oaks—*Quercus chrysolepis, Q. kelloggii, Q. wislizenii, Q. lobata, O. douglasii, Q. agrifolia, Q. dumosa, Q. durata* and *Lithocarpus densiflora.* The occurence of *Q. garryana* extends the known distribution southward from Marin Co., California. The only known occurence of *Pinus ponderosa* in San Luis Obispo Co. is on Pine Mountain. Like Yellow Pine, certain herbaceous plants, e.g. *Allium unifolium* and *Cordylanthus platycephalus,* have their known San Luis Obispo Co. distribution limited to Pine Mountain. Other widespread trees are *Acer macrophyllum Pinus coulteri, Pinus sabiniana* (at lower elevations) and *Arbulus menziesii.* The above plants with the exception of the shrub oaks form a dense woodland verging on forest conditions in some areas. Localized

situations have different mixtures of these trees but one need not go far to find most of the species mentioned.

Other herptiles collected on Pine Mountain were *Batrachoseps attenuatus Hyla regilla, Sceloporus occidentalis* and *Gerrhonotus multicarinatus. Rana aurora* and *Eumeces skilitonianus* were observed, but not taken. One *Gerrhonotus* had a snout hold upon another in a manner generally interpreted as courtship behavior.—RICHARD A. PIMENTEL, BIO. SCI. DEPT., CALIF. STATE POLY. COLLEGE, SAN LUIS OBISPO, CALIFORNIA.

AN INSTANCE OF TWINNING IN THE BOX TURTLE.—Conjoined twins and various duplication anomalies are sufficiently common among reptiles that almost every issue of the Zoological Record contains references to articles concerning two-headed, double-tailed, or polymelous monsters. The occurrence of completely separate and normally developed twins in oviparous reptiles appears to be rare, although the phenomenon may be more common than is generally realized inasmuch as it can be detected only if the hatching process is observed, if the twin-containing egg is opened just prior to hatching, or if the number of hatchlings is known to be greater than the number of eggs deposited.

On September 2, 1957, an opportunity was presented to the senior author to observe twinning when a set of three eggs of *Terrapene carolina triunguis* (Agassiz) was unearthed near Rogers, Benton County, Arkansas. Between September 9th and 12th, pipping was noted on all three eggs; on September 10th and 15th, two normal eggs hatched; on September 18th the slit was enlarged on the third egg and a living and a dead hatchling noted within the shell. The runt, which appeared to have drowned in the fluid, was beneath its twin and attached to it only by a common yolk stalk, fig. 1. The twins measured 15.5 and 25 mm. in carapace length at hatching and came from an egg 32 x 25 when discovered. The two normal hatchlings were 30 in carapace length at hatching and came from eggs 33 x 23 and 34 x 23 when discovered.

The completely separate twins are not identical. In addition to the disparity in size, the larger specimen has a better developed egg tooth and posterior fragmentation of the laminae so that there are six rather than five centrals and, on the left side only, five rather than four laterals.

Hildebrand (Jour. Hered. 29(7):243-253, 1938), who has summarized the subject of twinning in turtles, comments on its extreme rarity and reports that in over 100,000 eggs of *Malaclemys* reared in the hatchery at the Beaufort Station only one instance of complete "identical" twins had been encountered, although monsters were less rare. He cites the observations of Deraniyagala (Ceylon Jour. Sci. 8:73-102, 1933), who has noted repeated twinning in the eggs of *Dermochelys*. Duplica-

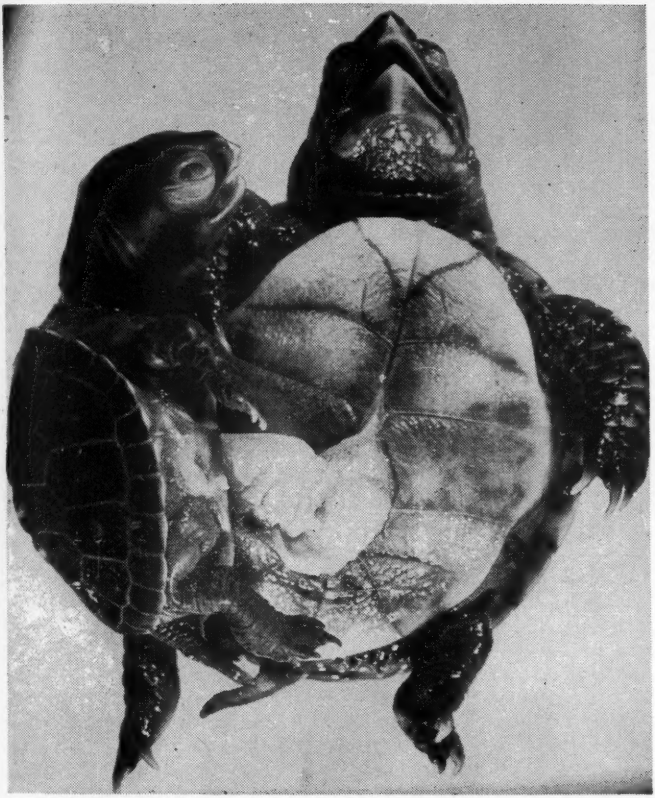

Fig. 1. A set of twin *Terrapene carolina triunguis* from Rogers, Ark. Photo by Wm. E. Clark.

tion at an early embryonic stage has been observed in another marine turtle, *Chelonia,* and is evidently not rare among fresh-water turtles, if judged by the number of dichotomous anomalies that have been reported in the literature. A check through the Zoological Record has revealed no instances of true twinning among turtles except as cited above. Among other oviparous reptiles true twinning has been reported in snakes (Curtis, Copeia 3:232, 1950) and lizards (Shaw, Herpetologica 10:73-78, 1954) in recent years and the phenomenon may possibly have been observed, but never reported, in other species. Dr. Fred R. Cagle, who has had much experience rearing hatchling reptiles, advises us (pers. comm.) that separate twins are exceedingly rare, but that partial twins are encountered more frequently.—*F. D. Crooks and Philip W. Smith, Route 2, Rogers, Ark. and Ills. Nat. Hist. Survey, Urbana.*

Experiments with Censusing of Southern Turtle Populations

By DONALD W. TINKLE

Because little information is available on the population density of river turtles, these data obtained from trapping and marking experiments with emydid and chelydrid turtles are presented. I am indebted to Dr. Fred R. Cagle of Tulane University for making the trips possible and to Mr. Whitfield Gibbons of Tuscaloosa, Alabama, for field assistance.

Most work on turtle populations has been concerned with long term studies of growth and movement (Cagle, 1942, 1944; Breckenridge, 1955). The present study was made to determine the feasibility of making rapid population estimates in rivers. The rivers studied were the Ouachita, 12 mi. E. Strong, Union Co., Ark.; Coosa, 6 mi. E. Pell City, Talladega Co., Ala.; and Black Warrior, 3 mi. E. Eutaw, Greene Co., Ala.

The Ouachita River was worked August 1-4, 1955, when it was fairly clear of silt, with a slow current, and with much brush in the water along the shore providing numerous basking and sleeping sites. Turtles were collected by the method of Chaney and Smith (1950). From 1920-2140, Aug. 1, along both banks of a 500 yard stretch of river (the study area), 12 *Graptemys kohni,* 4 *Graptemys pseudogeographica ouachitensis* and 9 *Pseudemys scripta elegans* were marked by notching the marginal shields by Cagle's (1939) technique. In addition 18 *Graptemys* sp. and 4 *elegans* were missed, making a total of 47 turtles encountered. From 1900-2100, August 2, 3 *kohni,* 1 *ouachitensis,* and 7 *elegans* were marked and 3 *kohni* and 1 *elegans* missed, a total of 15 in the same area worked the previous night.

On August 3, 1930-2330, the study area was worked twice and 21 *elegans,* 10 *kohni* and 2 *ouachitensis* were taken, of which one *ouachitensis* had been marked previously. Nine *Graptemys* sp. and 5 *elegans* were missed. In a 500 yard stretch of river (2330-0100) adjacent to the study area, 11 *elegans,* 5 *kohni* and 4 *ouachitensis* were collected while 3 *Graptemys* sp. and 2 *Pseudemys* sp. were missed. None of them had been marked.

On August 4 the study area was worked from 2000-2400, 5 *kohni* and 4 *elegans* were taken, and 3 *Pseudemys* sp. and 1 *Graptemys* sp. were missed. One *kohni* had been marked.

The fact that only 2 of 36 turtles marked (and of 96 captured) were recovered precludes population estimate on a mark-recapture basis, but several explanations are suggested: (1) marked turtles move out of the study area; (2) they become more wary after initial capture; (3) they no longer "sleep" in the brushpiles; (4) the number in the area is so great that the chance of recovering a marked one is remote.

On August 3 marginal areas were worked, but no marked turtles were found. This indicates that the marked turtles did not move into a marginal region or that they might be as difficult to recover outside the study area as within it.

There was a continued drop in the per hour catch during the 4 day period in the study area except on Aug. 3, a date which is not strictly comparable with the others because the area was worked twice. These data together with the basking counts of 16 turtles at 0900 Aug. 3, of

25 at 1600 Aug. 3, and of 30 at 1300 Aug. 4 indicate that the population density was not greater than that indicated by hand collecting at night. It is doubtful that all individuals in the area bask simultaneously, but if every basking turtle seen was a different individual then the figure of 71 basking compares favorably with the 120 encountered during hand collecting, some of which must have been the same individuals seen, but missed, on successive nights. The conclusion seems likely that turtles change their sleeping habits and become more wary.

Marking experiments were conducted in the Black Warrior River August 17-19, 1955 (Table 1) when the river was fairly clear, but so low that many brushpiles and trees that were normally in the water were exposed, eliminating many potential basking and sleeping sites. *Graptemps nigrinoda* and *Pseudemys scripta scripta* were caught by hand, marked and released; other turtles were removed.

August	Time Interval (Hours)	Number Marked	Number Recovered	Number Missed	Total
Graptemys nigrinoda					
17	2.5	15	0	2	17
18	4.5	19	1	0	20
19	2.0	9	3	5	17
Pseudemys scripta scripta					
17	2.5	3	0	0	3
18	4.5	3	0	0	3
19	2.0	1	1	1	3

Table 1. Data on two species of turtles marked in the Black Warrior River along both sides of a 2000 yard stretch of river.

The turtles, in addition to being notched, were painted with a fast drying pink fingernail polish. Four *Graptemys* and 1 *Pseudemys* were recovered; the painted turtles were noticeably more wary than unmarked ones which remained at rest in the brushpiles generally until caught. The painted turtles became uneasy when the boat approached the brush and began to move, but the painted carapace made them so conspicuous that the operator was able to see them far in advance of the brush and to speed the boat to catch them. These data suggest that the wariness of marked turtles is an important factor in decreasing recaptures.

The data are insufficient for more than a rough estimate of population density employing the modified Lincoln index comparing the number of marked to unmarked turtles. Using the method of Hayne (1949) a figure of 300 is obtained for Aug. 18; 136 for Aug. 19. However, as is usually the case with *Graptemys,* no adult females were taken, so any figure obtained will be low. Ten *Graptemys* were counted basking in the area at 1330 Aug. 19, of which one was painted and visible at 30 yards.

On August 14-16, 1954, the Tulane field crew worked this same locality and approximately the same area in two nights, obtaining 84 *nigrinoda* in 9.5 hours of hand collecting from a boat. At that time the river was higher with many more brushpiles, a fact that together with the heavy catch of 1954 may explain the poor one of 1955.

Seven traps with a diameter of about 15 inches and a length varying from 2-2½ feet were set and baited with whiting fish along a 200 yard stretch of river. These traps were visited from Aug. 17-19 during which time 12 *Sternothaerus minor peltifer* and 2 *Pseudemys s. scripta* were taken. All of the *peltifer* were taken on Aug. 17-18, none on the 19, indicating that most turtles in this length of river had been removed. If this is true the density of *peltifer* was one turtle per 16.7 yards.

The Coosa River was visited on the 20-21 Aug., 1954, and on the 13-16 Aug. 1955. In 1954 heavy rainfall had made the river muddy and high making collecting difficult. In 5.5 hours in two nights 2 *Pseudemys s. scripta,* 2 *Graptemys pulchra,* 3 *Sternothaerus odoratus* and 2 *Sternothaerus m. peltifer* were hand collected from a boat in brush. One basking census from 1500-1630, Aug. 21, revealed 7 *Pseudemys* and 2 *pulchra* in one mile. Several *Sternothaerus* were taken in small traps described previously.

The Coosa River was revisited in 1955 when the water was fairly clear of silt and at a normal level. Despite these changes only 1 *pulchra* was caught in 4 hours of hand collecting. During the afternoons only 2 *Pseudemys* were observed basking. A general idea of numbers of emydid turtles can usually be obtained by hand collecting and basking census.

The results from trapping over the three day period were more revealing of population density. Eight traps were run for three days on the east bank of the river and 5 for 2 days on the west bank. During this period 42 *scripta,* 19 *odoratus,* and 14 *peltifer* were taken. The traps were baited with whiting fish which was renewed in most traps each day. Traps with foul smelling bait were generally avoided by turtles, as were unbaited traps.

Species: Aug.	13	14	15	16	Total
Pseudemys s. scripta	13	16	10	3	42
Sternothaerus odoratus	5	6	6	2	19
Sternothaerus m. peltifer	1	7	3	3	14

Table 2. Numbers of three species of turtles trapped over a four day period in the Coosa River, Alabama with 13 traps in August, 1955.

There was a gradual decrease in the daily yield (table 2). On the east bank no turtles were caught after the second day. If this indicates that most turtles within feeding range of the traps had been caught, then trapping data yield good information on population density at least of these species that, unlike *Graptemys,* are easily trapped.

Continual disturbance of the trapping area may frighten turtles and cause a decrease in trap efficiency. It is not known how far the turtles move to get to the bait in the nets, but assuming that the influx from without the trapping area is negligible, an estimate of three species is possible in 350 yards of the river. Extrapolating the catch on the west side to 350 yards and assuming that all turtles had been trapped on the west, the density of *peltifer* would be one per 17.0 yards (similar to that in the Black Warrior); of *scripta,* one per 7.2 yards; and of *odoratus,* one per 13.7 yards.

The data indicate that with refinement of technique and development of new ones for some species, comparable and reliable estimates of population density of turtles in rivers may be obtained by trapping and marking experiments in a relatively short time.

LITERATURE CITED

Breckenridge, W. J.
1955. Observations on the life history of the soft-shelled turtle, *Trionyx ferox,* with especial reference to growth. Copeia no. 1, 5-9.

Cagle, Fred R.
1939. A system of marking turtles for future identification. Copeia no. 3, 170-172

1942. Turtle populations in southern Illinois. Copeia no. 3, 155-162

1944. Home range, homing behavior and migration in turtles. Misc. Publ. Mus. Zool. Univ. Mich. no. 61, 1-34.

Chaney, Allan and Clarence L. Smith
1950. Methods for collecting map turtles. Copeia no. 4, 323-324.

Hayne, Don W.
1949. Two methods for estimating population from trapping records. Jour. Mamm. 30(4): 399-411.

TEXAS TECH. COLLEGE, LUBBOCK, TEXAS

THE LIZARD *EUMECES TETRAGRAMMUS* IN COAHUILA, MEXICO.—On June 29, 1957, I captured a *Eumeces tetragrammus* Baird, 3 mi. W Cuatro Cienegas in central Coahuila, Mexico. Not previously known from Coahuila, the species was thought to be confined to the coastal region from southern Texas to northern Veracruz. It is an adult male, 56 mm. snout to vent, with distinct though narrow dorsolateral light lines continuous to base of tail, and lateral lines weakly differentiated from the grayish-white venter. In life, the lateral region between the light lines was dark brown, dorsal field pale brown, chin white, lips and sides of neck orange. The identity was checked by comparison with examples from Texas, and Dr. Hobart M. Smith concurred in identification.

The skink AMNH 77316 was found in a canyon in the 3 foot wide fringe of vegetation along a spring-fed stream. Away from the stream, hot and arid conditions prevailed. Cuatro Cienegas is 200 miles from the nearest recorded stations for *tetragrammus* east and northeast in Starr and Frio counties, Texas. The present record adds another species of generally more northern or eastern distribution to the fauna of Coahuila. Worthy of note in this respect in addition are *Coluber constrictor stejnegerlaterale* and *Acris crepitans* in the vicinity of Múzquiz and *Natrix rhombifera* at Las Rusias. Each represents a single, isolated record, and probably some or all represent disjunct populations that reached their present locations during a pluvial period.—*Richard G. Zweifel, Department of Amphibians and Reptiles, The American Museum of Natural History.*

Variation in the Species of Cadea (Amphisbaenidae), and a Record of C. *blanoides* from the Isla de Pinos

By GEORGE R. ZUG AND ALBERT SCHWARTZ

The genus *Cadea,* represented by two species, is restricted to Cuba and the Isla de Pinos (Vanzolini, 1951:114). Two species are recognized: *Cadea blanoides* Stejneger, from western Cuba, and *Cadea palirostrata* Dickerson, from the Isla de Pinos. The herpetofauna of the Isla de Pinos closely resembles that of Cuba and is composed of either identical species or usually weakly differentiated subspecies, but in the case of *Cadea,* the forms are very distinct.

Barbour and Ramsden (1919:182) stated that "*Cadea palirostrata* may possibly be quite unrelated to *blanoides,* and in that case it may surely be looked for in Cuba as *blanoides* may be in the Island of Pines." During the Christmas holidays of 1957-58, in the company of Edwin B. Erickson and Willard M. Stitzell, we collected on the Isla de Pinos. Among the reptiles is a single specimen of *Cadea* (AMNH 78397) from the west base of the Sierra de las Casas, just west of Nueva Gerona. It is not *palirostrata,* heretofor the only species known from the Isla de Pinos, but represents the first record of the Cuban *blanoides* from the Isla. In an effort to compare this specimen with both *blanoides* and *palirostrata,* we borrowed specimens of both species from various collections and feel that we have examined more *Cadea* than any previous workers. It seems appropriate to present the data from the present study, despite the fact that *blanoides* is still poorly represented in collections and that our Isla de Pinos specimen appears to be like Cuban material. We wish to thank the following for the courtesies extended in the loan of these rare amphisbaenids: Mr. Charles M. Bogert, American Museum of Natural History (AMNH); Dr. Ernest E. Williams, Museum of Comparative Zoology (MCZ); Dr. Doris M. Cochran, United States National Museum (USNM). We also wish to thank Mr. Robert J. Marsh for his aid in the calculations.

The following specimens of *Cadea* have been available to us; although there are probably a few others, we suspect that this lot represents the majority of *Cadea* now preserved in this country: *Cadea blanoides:* Cuba, no other locality, 3 (USNM 5729, 36811-12); Pinar del Río Province, Cueva de Santo Tomas, 10 km. N Cabezas, 1 (AMNH 77789); San Diego de los Baños, 2 (USNM 27845, MCZ 7934); Herradura, 1 (MCZ 7935); Guanajay, 1 (USNM 27846); Habana Province, Caimito de Guayabal, 4 (MCZ 13571-74); Habana, El Cotorro, 2 (AMNH 46678-79); Isla de Pinos, Sierra de las Casas, just west of Nueva Gerona, 1 (AMNH 78397. *Cadea palirostrata:* Isla de Pinos, La Ceiba, 5 (AMNH 12809-10, MCZ 12331-33); San Pedro, 2 (USNM 54379—paratype; MCZ 12052); McKinley, 1 (MCZ 12088); Santa Barbara, 6 (MCZ 12448-54); Nueva Gerona, 10 (MCZ 13506-12, 13514-16).

Dickerson (1916) described *palirostrata* on three specimens. She distinguished the new species from *blanoides* on the basis of the vertical compression of the head and the head scalation. In *palirostrata,* the nasals form a long suture only with the rostral, whereas in *blanoides* the nasals form a suture with both rostral and prefrontal. This combination of

characters suffices to distinguish the two species and no intermediate specimens have been encountered. Mere inspection reveals the narrow and much compressed head of *palirostrata* in contrast to the wide and cylindrical head of *blanoides*.

Apparently no one has attempted to determine the sex of any specimens of Cadea. We have sexed our lizards by slitting the ventral surface of the tail and searching for hemipenes; in general this technique is satisfactory.

We have counted dorsal annuli from the posterior edge of the parietals, along the midline of the dorsum, to the annulus which bounds the vent. Dorsal annuli in *blanoides* vary between 201 and 221, whereas in palirostrata between 306 and 347. By sexes, the dorsal annuli are: blanoides, nine males, 209.4 (201-221), five females, 210.2 (208-214); *palirostrata,* 11 males, 329.6 (313-343), 12 females, 330.4 (306-347). There is no sexual dimorphism in this character in either species. Ventral annuli were counted starting with that annulus which, ventrally, is a complete continuation of the first dorsal annulus (*i.e.,* just posterior to parietals), to the vent. These counts on the same number of specimens of both sexes, are: *blanoides,* males, 194.8 (175-218), females, 189.0 (184-198); *palirostrata,* males, 282.4 (274-300); females, 296.4 (276-302). Dorsal and ventral tail annuli in *blanoides* are: males, 14.3 (13-18), 11.2 (9-13); females, 13.8 (12-16), 10.8 (10-13). In *palirostrata,* the dorsal and ventral tail annuli are: males, 20.8 (19-24), 15.8 (14-19); females, 19.9 (17-23), 14.7 (12-16). In both species, females tend to have slightly shorter tails with fewer annuli. In summary, on the basis of these scale counts, *blanoides* and *palirostrata* demonstrate little sexual dimorphism. *C. blanoides* has from 25 to 33 segments in a mid-body annulus, whereas *palirostrata* has from 32 to 39.

The largest male *blanoides* measures 260 (all measurements in millimeters) in total length, and the largest female 220. The largest male *palirostrata* 274 and the largest female 264. Females appear to be smaller than males in both species, but the apparent difference between sexes in *blanoides* may be an artifact of the small sample and the sexual difference in size in *palirostrata* is not great. No *blanoides* shows the umbilical scar; the smallest individual (AMNH 77789) is 122 in total length. Two small *palirostrata* (MCZ 12448-49) measure 118 and 124 respectively; both are females. Both have an umbilical scar, the former between annuli 237 and 242, the latter between 229 and 234. There is little doubt that these were recently hatched and they give some indication of the size of *palirostrata* at the time of hatching. That the smallest *blanoides* lacks an umbilical scar but is intermediate in size between the two scar-possessing *palirostrata* may indicate that the Cuban species hatches at a smaller size than the Isla de Pinos form.

The number of anal segments and the number of preanal pores have been considered as diagnostic. Barbour and Ramsden (*op. cit.*: 181) give 8 anal segments and 8 preanal pores for a specimen of *blanoides;* Dickerson (*op. cit.*: 659) regarded 10 anal segments and 10 preanal pores as characteristic of *palirostrata.* Our data indicate that these characters are variable; in *blanoides,* the anal segments vary between 6 and 8 and the preanal pores between 4 and 9, whereas in *palirostrata* the anal segments range from 6 to 10, and the preanal pores from 6 to 11 (see Table 1.)

Table 1. Variation in number of anal segments and number of preanal pores in 15 *C. blanoides* and 24 *C. palirostrata.*

	blanoides						*palirostrata*					
Anal segments	6	7	8				6	7	8	9	10	
Individuals	4	1	10				1	1	10	4	8	
Preanal pores	4	5	6	7	8	9	6	7	8	9	10	11
Individuals	2	0	0	1	11	1	1	1	4	4	13	1

The variation in these two characters is thus shown to be far greater than suspected by Barbour and Ramsden, and Dickerson. The most unusual of the series of *blanoides* are a male and female from El Cotorro; both have 6 segments and 4 pores. These are the most eastern *blanoides* known, and it is a possibility that, should additional material from Habana and Matanzas provinces demonstrate this low number of segments and pores, they may represent an undescribed subspecies. I believe this pore-segment proposition would be greatly clarified in a short table.

The scutellation of the head is likewise constant for each species. The palirostrata show no important variation and agree in detail with that described by Dickerson for the type. Of the *blanoides,* only one departs from the description by Barbour and Ramsden. This small lizard (AMNH 77789) has two supraocular scales on each side, instead of the single supraocular characteristics of *blanoides.* Occasionally the single supraocular may be partially divided by an incipient suture, but only this one lizard shows the complete division of the scale.

The Isla de Pinos *blanoides* appears exactly like the Cuban *blanoides.* The Isla de Pinos specimen is an adult male, 208 in total length, tail 16; 214 dorsal annuli, 211 ventral annuli, 14 dorsal and 12 ventral annuli on the tail, 6 anal segments, 8 preanal pores and 30 segments in a mid-body annulus. In all counts taken, this specimen falls within the known variation of Cuban specimens.

We can add but little to the natural history of *C. blanoides.* The Isla de Pinos specimen was taken beneath a rock in a rock-strewn area at the base of a cliff at the west base of the Sierra de las Casas; a rather large box canyon. It was taken from beneath a rock on the moister, shaded side of the canyon. Another specimen, collected by William H. Gehrmann at Cueva de Santo Tomas in the summer of 1957 and seen in life by the junior author, was captured from beneath a rock on the top of a rock pile, the interstices of the pile being filled with moist soil. The ground color of the Santo Tomas specimen was pale purplish pink in life (Pl. 42, D 4 in Maerz and Paul, 1950) with gray dorsal dotting.

In summary, the variation in *blanoides* and *palirostrata* has been shown to be more extensive then previously known and the occurrence of the former species on the Isla de Pinos, as intimated by Barbour and Ramsden, has been established.

LITERATURE CITED

Barbour, Thomas, and Charles T. Ramsden. 1919. The herpetology of Cuba. Mem. Mus. Comp. Zool., 47(2): 71-213.

Dickerson, Mary C. 1916. Description of a new amphisbaenian collected by the late Dr. Charles S. Mead in 1911, on the Isle of Pines, Cuba. Bull. Amer. Mus. Nat. Hist., 35(34): 659-662.

Maerz, A., and M. Rea Paul. 1950. A dictionary of color. New York, McGraw-Hill Book Co., v-vii, 1-208, 56 pls.

Vanzolini, P. E. 1951. A systematic arrangement of the family Amphisbaenidae (Sauria). Herpetologica, 7(3): 113-123.

DEPT. BIOL., ALBRIGHT COLLEGE, READING, PENNA.

NOTES ON REPTILES AND AMPHIBIANS FROM FLORIDA CAVES.—The occurrence of reptiles and amphibians in cave habitats has recently received attention. Brode (Copeia, 1958: 47-48), Barr (Copeia, 1953: 60-61) and Brown and Boshung (Copeia, 1954: 226) have reported on the herpetofauna of caves in Mississippi, Tennessee and Alabama.

The following notes are based on amphibians and reptiles observed in two Florida caves during paleontological excavations. These caves, formed by the solution of the Eocene Ocala limestone, must be entered through vertical shafts or "chimneys." They reflect the mean annual temperature of the areas in which they occur and contain varying amounts of water depending upon the precipitation.

Saber-tooth Cave; located one and two-tenths miles northwest of Lecanto, Citrus Co., Fla. is entered through two 15 foot vertical shafts and was dry when the following frogs were observed Aug. 9, 1957.

Rana pipiens sphenocephala Cope. One adult. Fossils identified tentatively as this species were taken from Pleistocene deposits in the cave indicating a long association of this species with Saber-tooth Cave.

Rana capito Le Conte. One sub-adult.

Bufo terrestris terrestris Bonnaterre. One adult.

Grant's Cave; located nine and three-tenths miles west of Gainesville, Alachua Co., Fla. is entered through a 34 foot vertical shaft and is the roosting place for thousands of bats (*Myotis austroriparius*). It contained water during the 1955 and 1956 visitations when the following animals were observed.

Rana catesbeiana Shaw. In recent years Grant's Cave has supported a fauna of large bullfrogs (Carr and Jennings, personal communication). Three adults were observed by the writer during the fall, winter, and spring of 1955 and 1956. They were in total darkness. The stomach of a female (snout-vent length 112 mm., head width 48, taken December 9, 1955) contained large numbers of cockroaches (*Periplaneta americana*). Cockroaches are very numerous in Grant's Cave, feeding on the large deposits of bat guano. A male bullfrog (snout-vent length 155, head width 67) was caught and marked February 22, 1956. It was very sluggish and emaciated. It was observed in different parts of the cave February 23, 24, and 28, March 4, 6, 10, and 13 and travelled about

120 feet during this time. On March 20 it was found dead. The third frog caught March 6, 1956 was marked and released but not observed again. Ranid bones in comparison with other vertebrate bones from post-Pleistocene deposits on the cave floor indicate that the genus has had an association with Grant's Cave surpassed only by the bat (*Myotis austroriparius*). Although the ranid ecological role is and has been important in Grant's Cave, there is no evidence that the frogs have ever bred there.

Elaphe guttata Linnaeus. Carr (1940, Univ. Fla. Publ., 3: 82) reports *Elaphe obsoleta* in a cave in Citrus County, Florida and Rice (M.S. Thesis, Univ., Fla. 1955) reports *Elaphe obsoleta* and *E. guttata* from various Florida Caves. Two corn snakes, 26 and 32 inches in length, were obtained Feb. 28 and Mar. 17, 1956 in Grant's Cave in total darkness. Although palpated, they yielded no food. It is believed these snakes feed upon bats and possibly on mice (*Peromyscus gossypinus*) which are present in the cave. These snakes probably enter and leave the cave at will as two additional specimens were seen crawling up the cave shaft by Charles J. Flora of Western Washington State College. The two specimens examined by the writer were very lethargic and showed no hostility on being handled.

Pseudemys scripta scripta Schoepff. A specimen with a shell length of six inches was observed in Grant's Cave in January of 1956. As Grant's Cave is very far from permanent water, this record may shed light on the appearance of Pleistocene pseudemyd turtles in mainly terrestrial assemblages from Florida.—*J. Alan Holman, Department of Biology, University of Florida, Gainesville, Florida.*

ALLIGATOR LIZARD NOTES.—While engaged in ecological studies on the San Diego alligator lizard (*Elgaria multicarinata webbi* Baird) (Cunningham, 1956, Herpetologica, 12: 225-230), the writer had ocacsion to examine specimens of several other species and subspecies.

Eighteen Coronados Island alligator lizards (*E. m. nana* Fitch), three red-backed alligator lizards (*E. m. multicarinata* Blainville), two Sonoran alligator lizards (*E. kingi* Gray), and one San Francisco alligator lizard (*E. c. coerulea* Wiegmann) were found to contain eggs.

The average number of eggs found in *nana* was slightly over eight, with a range of three to seventeen. As might be expected, the larger the female, the greater the number of eggs. The average number of eggs discovered in *multicarinata* was seven. The single *coerulea* contained 8 eggs.

Notes accompanying a *kingi* in the Los Angeles County Museum collection indicate that a female from the Chiricahua Mountains, elevation 7,000 feet, deposited twelve eggs June 17, 1917. Another *kingi* from the Sierra Ancha Mountains, collected July 24, 1935, contained 9 eggs.

Four Sierra alligator lizards (*E. coerulea palmeri* Stejneger) were hatched in late September from eggs deposited by a 95 mm. (body length) female collected in late July, 1945, at an elevation of 9,000 feet in the Sierra Nevada Mountains. Notes on file in the Yosemite National Park Museum indicate that a pair of Sierra alligator lizards was discovered mating near Ribon Fall, Mariposa County, on May 26, 1940. The highest elevation that *palmeri* has been discovered in the Yosemite region is on Red Peak, 10,500 feet.—*John D. Cunningham, Department of Education, U.C.L.A., Los Angeles 24, California.*

Miscellaneous Notes on Ecuadorian Snakes

By James A. Peters

In anticipation of the publication of my check list of the snakes of Ecuador, which is currently in the editor's hands, I would like to record the presence of several species of snakes previously unknown in that country. Most of these have been expected there, since their occurrence in neighboring countries has long been known. One, *Ninia hudsoni* Parker, is known only from the type series from British Guiana so its presence in Amazonian Ecuador is an interesting range extension.

Anilius scytale Linnaeus

Anguis scytale Linnaeus, 1758, Syst. Nat., 10th Ed., vol. 1, p. 228.

The specimen recorded here is UMMZ 90815, collected on the Rio Cotopino, in Amazonian Ecuador. The range in general is throughout the Amazonian basin. This female has 266 ventrals and 12 caudals; five upper labials, the third and fourth entering orbit; five lower labials; no loreal, no preoculars, two postoculars, no temporals or internasals. There are 89 black bars on the body, and one on the tail. The scale row reduction is:

$$21 - 4 \frac{9}{10} 19 + 6 \frac{65}{68} 21 \frac{5+6\ (238)}{?} 19 \frac{-6\ (250)}{-7\ (251)} 17\ (266).$$

The specimen is of interest because of the high ventral and blotch counts. This was first pointed out by Philip J. Clark, and independently noted by Janis Roze, who is currently reviewing the genus. It is likely that this specimen represents a taxonomically distinct population.

The Escuela Polytecnica Nacional of Quito, Ecuador, has specimens which I have not examined. The CNHM has one, 16943, recorded from Guayaquil, which I have not seen, and which, if correctly identified, represents an unexpected locality record.

Ninia hudsoni Parker

Ninia hudsoni Parker, 1940, Ann. Mag. Nat. Hist., ser. 11, vol. 5, p. 270.

Previously known only from the types, in the Brit. Mus. (N. H.), from the New River, British Guiana. There are three in UMMZ from Ecuador, 88914, from the Rio Pastaza, and 90818 (2 specimens) from the Rio Cotopino. These specimens agree with the type description. The head shields are clearly striated and all have 21 rows. The length-depth ratio for the loreal is not as clear cut as Parker indicated (1.06-1.11 in *hudsoni*, 1.3-2.0 in *strata*), for in these three the ratios are: 1.25; 1.33; and 1.46. The segmental counts, given in the same order are: ventrals 144, 143, 144; subcaudals 55, 64, 64. Other variations from the type description are: one has a single postocular, all have one primary and two secondary temporals and one has the third, fourth, and fifth labials in the orbit, although it has the typical seven labials.

I would like to give notice that I have petitioned the International Commission on Zoological Nomenclature to permit retention of the name *Ninia atrata* Hallowell for the most common species of the genus in South America, although Burger and Werler (Univ. Kans. Sci. Bull.,

vol. 36, no. 2, 1954, p. 649) have shown that name to be a primary homonym of *Coluber atratus* Gmelin, 1788. Herpetologists should continue to use the name *Ninia atrata* Hallowell until the decision has been formulated by the Commission.

Siphlophis cervinus cervinus Laurenti

Coronella cervinus Laurenti, 1768, Syst. Rept., p. 88.

Amaral (Mem. Inst. Butantan, vol. 9, 1935, p. 206) gave the range of this subspecies as western and northern Brazil, Paraguay, Bolivia, Upper Amazonas, Colombia, Panama, Venezuela, Trinidad and the Guianas, so it is not surprising that one has been taken in Ecuador; now in the collection of Gustavo Orces-V., of Quito, Ecuador (OVS 1040), who has permitted me to examine it. It was collected near the Rio Bobonaza, in Amazonian Ecuador; is typical of the species, with 17 maxillary teeth followed by a diastema and then two enlarged, grooved teeth and with the fourth through the seventh mandibular teeth greatly enlarged, being more than twice as long as the remaining mandibular teeth. Nine upper labials; the third, fourth, and fifth in the orbit; third labial elongated, extending back over the fourth to enter orbit in a point; seventh labial greatly reduced and much smaller than the sixth or eighth; loreal present; one preocular and two postoculars; primary temporals two on left and three on right; secondaries three on both sides and four tertiaries. All head scales are covered with tiny pustules. Ten lower labials, four contacting the first chin-shield on left, five on right; 235 ventrals; anal entire; 108 caudals; 21-19-17 rows, but reductions cannot be given because of a great many fusions and divisions of scales.

There are about 88 irregular narrow blotches on the body, which are two or three rows wide and separated by a single row. The ground color is almost white on the sides, but the vertebral area is somewhat reddish, forming a discontinuous vertebral stripe, often broken by contact of opposing blotches; venter straw yellow, with brown streaks extending well onto or across ventrals, from the ends of the blotches. All scales of head are dark in the center with markedly lighter edges. Some of the larger scales, such as the parietals or frontal, have a lighter area within the dark color which forms a ring. There are a few dark spots on the lower labials, but the rest of the chin is slightly darker yellow than the belly.

Eunectes murinus Linnaeus

Boa murina Linnaeus, 1758, Syst. Nat., 10th Ed., vol. 1, p. 215.

Widely known from the Amazonian Basin, but not previously recorded from Ecuador, where its occurrence is based upon a specimen in the Universidad Central, in Quito, Ecuador. It has been carefully checked by Dr. Gustavo Orces-V., and the identification is acceptable. It was collected on the Rio Pindo, on the eastern slope of Ecuador. According to Dr. Orces-V., "the species is extremely rare along the Bobonaza but common in the region of the Conambo and Pindo rivers." Amaral (Mem. Inst. Butantan, vol. 4, 1929, p. 141) gave the range as Brazil, Peru, Guianas, Trinidad, and Colombia.

UNIVERSIDAD NACIONAL, QUITO, ECUADOR

TWO NEW CALIFORNIA LOCALITY RECORDS FOR *ARIZONA ELEGANS OCCIDENTALIS*.—On April 27, 1958, the author, in company with Mr. David E. Brown, secured a juvenile female *Arizona elegans occidentalis* Blanchard from Antioch (1.8 miles west on Wilbur Ave. from the junction with Bridgehead Road) along the San Joaquin River, Contra Costa Co., Calif., now no. 21511 in the reptile collection of the Stanford Univ. Nat. Hist. Museum, was found under a board on the beach sand dunes. Two lizards, *Uta stansburiana hesperis* and *Anniella pulchra pulchra,* were also found in the area. The dunes were covered with blue flowering lupines.

This represents a range extension of approximately 30 airline miles north to the junction of the San Joaquin and Sacramento Rivers. It might suggest the possibility of the occurrence of the Glossy Snake in the Sacramento Valley.

The previous most northern locality was Coral Hollow Creek (7 miles south southwest of Tracy and 3 miles east of Tesla), San Joaquin Co., Calif. (Klauber, 1946, *Trans. San Diego Soc. Nat. Hist.*, Vol. 10, p. 378).

Scale rows, 28-29-19; ventrals, 207; caudals, 49; anal entire; supralabials, 8; infralabials, 13; nasals, 2; loreals, 1; preoculars, 1; postoculars, 2; temporals, 2 + 3. The specimen differs from more southern populations in lacking a brown streak from orbit to angle of mouth, and in having 207 ventrals instead of from 215 to 231 (Klauber, *op. cit.*, p. 373).

Another *Arizona elegans occidentalis* was collected by the author June 2, 1956, six miles east of Mt. Hamilton, Santa Clara Co. It was found dead in Arroyo Bayo Creek. Scale count at midbody 28. This seems to be the only record for Santa Clara Co., and substantiates the subspecies in the San Antonio Valley.—*Bart W. Crawford, 1651 Tulane Drive, Mountain View, California.*

AN ERYTHRISTIC SPECIMEN OF NORTHERN WATER SNAKE FROM GEAUGA CO., OHIO.—On August 14, 1958, a very interesting 37-inch erythristic Northern Water Snake *Natrix s. sipedon* (Linnaeus) was brought to the Cleveland Museum of Natural History.

The coloration as described in Wright and Wright's *Handbook of Snakes,* 1957, is: blackish-brown back, clove-brown head, dark olive-buff upper labials with sutures of clove-brown and greyish-olive transverse dorsal bars.

This specimen has: pinkish back, greyish head, white upper labials with sutures of greyish-brown and greyish transverse dorsal bars bordered with greyish-white and black.

Another erythristic specimen is reported by Wright and Wright's *op.* cit., from Mountain Lakes, N.J.—*Lindsay W. Wood, Cleveland Museum of Natural History, 10600 East Boulevard, Cleveland 6, Ohio.*

SEXUAL DICHROMATISM IN *SPHAERODACTYLUS NOTATUS* (REPTILIA: LACERTILIA).—The sexual dichromatism of *S. notatus* Baird, has not been published although it is marked and of interest. The original description by Baird (Proc. Acad. Nat. Sci., Philadelphia, 1858:254) states: "*Sphaerodactylus notatus* Baird,—Scales on the back and sides large, equal, strongly carinated; those on belly smaller, smooth, hexagonal. Above light brownish yellow, uniformly dotted above with reddish brown, most distinct on the head, least so on the belly. Hab.—Key West, Fla., Prof. Agassiz and Prof. W. H. B. Thomas. Type No. 3215." Type in the Acad. Nat. Sci., Philadelphia. Baird's mention that the head was dotted makes it appear that the type was a young male.

Barbour, in his monograph on *Sphaerodactylus* (Mem. Mus. Comp. Zool., 1921:257), gives the following distribution: "Abundant in all parts of Cuba, the Isle of Pines, and nearly every Bahama Island that has been explored. Probably more widespread in the southern part of Florida than has been expected."

The unexpected and unexplained extremely limited distribution of other members of this genus makes it doubtful whether the distribution mentioned by Barbour will hold when larger series are available for comparison and possible justifiable separation.

The colorpattern of 8 males and 6 females taken at Banes, Oriente, Cuba, Apr. 9-23, 1956, show the following sexual dichromatism.

Top of Head: Young males, vermiculated dark and light. Adult males, brown with large darker spots not confined to individual scales, but apparently including the skin as well. Females, dark brown hourglass pattern from between eyes to occiput, bordered by lighter brown.

Side of Head: Young males, two light stripes bordered by dark from eye to neck, or vermiculated. Adult males, no stripes, but with small dark spots on light brown. Females, stripes more pronounced, but darker.

Throat: Young males, white, spotted with groups of black scales. Adult males, dark spots tending to disappear, leaving throat clearer. Females, heavily dotted with black, often with white vermiculations, or clear with few minute dark dots.

Belly: Young males, almost clear, scales edged with minute dots. Adult males, clearer. Females, scales edged with minute black dots, much darker than in males.

Escutcheon: Young males, escutcheon first appears as a small patch on midline, gradually extending onto thighs; scales edged with minute black dots. Adult males, scales clearer or free from dots; mature escutcheon 5 to 6 scales long extending ten scales from midline onto each thigh, two or occasionally three scales wide. Females, no escutcheon, but the equivalent region more heavily speckled than rest of belly.

Back: Males light brown with about 10 rows of dark dots occupying roughly alternate rows and appearing usually on alternate scales. These dark scales appear only dark-edged on young males, becoming entirely dark on adults. Females, darker; stripes from head usually extend half length of body; rows of dark scales barely discernible because of darker background.—*Chapman Grant, R 1, Box 80, Escondido, Cal.*